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THE HARVARD PROF HUNTING FOR ALIEN SPIES

Science Focus

How the Higgs boson
COULD REWRITE PHYSICS AGAIN

How gene editing can
CREATE ACTUAL SUPERFOODS

Should we let
GADGETS READ OUR BRAINS?

THE MENTAL HEALTH ISSUE

A mental toolkit for conquering anxiety

Why your social fitness matters

How your brain's fingerprint can predict disorders before they happen

Have social networks ruined childhood?

Dr TikTok will see you now: why mental health self-diagnosis is a dangerous trend

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Ticks
Why they're on the rise and what to do if you get bitten

Diet
What most people get wrong about shedding fat

AI
It's your boss, not the machines you should be worried about

ADVERTISEMENT FEATURE

AN IMPORTANT MESSAGE FROM PROFESSOR NICK LEMOINE CBE MD PHD FMEDSCI, CHAIR OF THE MEDICAL RESEARCH FOUNDATION

Gifts in Wills could be the key to protecting the future of human health

Our experience of COVID-19 shows how suddenly a global health challenge can appear. As someone interested in science, you will understand that while nobody can predict what we will face next, we can be certain that the future will bring many more threats to human health.

As Chair of the Medical Research Foundation – the charitable arm of the Medical Research Council – I have seen the incredible impact that individuals who remember the Foundation in their Wills can have on the future of our health and wellbeing here in the UK. These gifts fund research and researchers which can have far-reaching implications for human health.

With a gift in your Will you can play a key role in providing the science that will protect the health of future generations.

Right now, the Foundation is funding research to tackle antimicrobial resistance, and investing in researchers like Dr Myrsini Kaforou – who will make the fight against antimicrobial resistance her life's work.

Without support at the crucial early stages, researchers like Dr Kaforou can be forced to abandon their passion and leave science altogether, with an immeasurable loss to future human health. Gifts in Wills provide the long term funding and security that allows the Foundation to invest in projects like Dr Kaforou's and lay the foundations for quality research in years to come.

Your Will can fund the rational response to health challenges that medical science provides.

> **"As scientists, our duty is to secure the future of research for the generations that follow."**
>
> Professor Fiona Watt, Patron of the Medical Research Foundation and Director of the European Molecular Biology Organization.

While we don't know what the future holds for human health in the UK, we do know that research, and the brilliant scientists driving that research forward, are the key to meeting those challenges for years to come.

"The funding I received through the Medical Research Foundation will be transformative for my research." Dr Myrsini Kaforou

But many of these scientists rely on the generosity and foresight of fellow members of the medical community who understand the power of science and are willing to leave a gift to medical research in their Wills. At the Medical Research Foundation, over 90% of our voluntary income comes from individuals who choose to include a gift in their Will – they are crucial in the Foundation's ability to fund research that will enable the next generation of scientists to make real world discoveries in the future.

I firmly believe that a gift in your Will to the Medical Research Foundation is an excellent investment and will have a lasting impact on science and on the future of human health in the UK.

Please consider this very special gift today.

Professor Nick Lemoine CBE MD PhD FMedSci
Chair of the Medical Research Foundation

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FROM THE EDITOR

Your brain is a tough nut to crack. Psychologists have been trying to understand what's inside our heads for over a century (which actually isn't very long, as science goes), and there are still gaping cavities at the roots of our models. We have a pretty good understanding of how each of our senses work – how we see, touch, feel, hear and smell – but not so much how we generate consciousness – our sense of being. We have some sound models of what happens when we try to remember something, but no definitive picture of how those memories are created, or encoded, in the first place. This, in the face of our understanding of the rest of the Universe – of black holes, of distant worlds, of our own genetic code and so on – seems a bit disappointing.

It's so disheartening in fact, that there's even a school of thought that says we might never be able to fully understand the brain. There's just too much navel-gazing going on; in other words, our brains might be too limited to ever really understand how they do what they do.

I'm mentioning all this, not because I'm having another existential crisis (I save those for the holidays) but because May is Mental Health Awareness month around the world. This inspired us to devote a whole issue's worth of features to the subject. But as we debated which stories we could fit on our pages, it became clear just how much we still don't understand about what happens when our minds – the product of our brains – get ill. That said, this issue has taught me one thing for sure: that we're happier and healthier when we're together (p58), which is nice. So in that spirit, we hope you enjoy the issue and find someone to share it with.

Daniel Bennett, Editor

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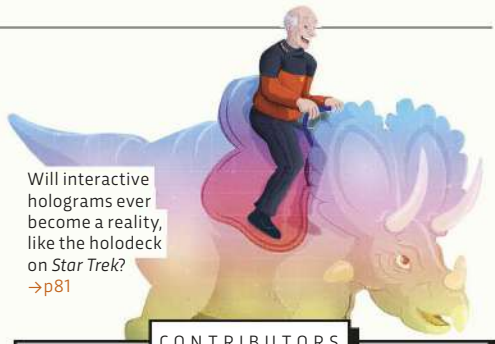

Will interactive holograms ever become a reality, like the holodeck on *Star Trek*? →p81

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PROF PETE ETCHELLS
A professor of psychology, Pete researches how screens, and in particular video games, affect children. We asked him whether social media is ruining childhood. →p70

GINNY SMITH
Neuroscience expert Ginny finds out whether the blueprints of teenagers' brains can predict their likelihood of suffering poor mental health. →p74

PROF STEPHON ALEXANDER
In his first column, Stephon investigates the idea that the Higgs boson may have been involved in the birth of the Universe. →p32

DR EMMA BECKETT
Emma is a food and nutrition scientist at the University of Newcastle, Australia. She explores the potential for gene-edited food to boost our health. →p38

CONTACT US

Advertising
David.DSouza@ourmedia.co.uk
0117 300 8110
Letters for publication
reply@sciencefocus.com
Editorial enquiries
editorialenquiries@sciencefocus.com
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ON THE BBC THIS MONTH...

Sliced Bread
Sliced Bread returns with a new series that cuts through the advertising hype to find out whether the latest wonder products really do what they claim. First to go under the microscope this season, are anti-snoring devices and barefoot running shoes.
BBC Radio 4,
11 May, 12:30pm
Also available on BBC Sounds

People Fixing the World: Making peace with nature
Many of the planet's most violent conflicts take place in its most valuable natural wildernesses, but what happens once the fighting stops? This series explores how nature and people can recover after war. In this episode, the team visits a project in Columbia that trains former guerrilla fighters to create ecotourism initiatives that protect biodiversity.
BBC World Service, 9 May, 3pm
Also available on BBC Sounds

CrowdScience: Why am I so lazy?
If, like me, you think of life as a perpetual fight against the joy of inertia, then this episode of *CrowdScience* is for you. The team uses a bit of science to explain why a little laziness is no bad thing.
BBC World Service,
12 May, 8:30pm
Also available on BBC Sounds

COVER: EIKO OJALA THIS PAGE: GETTY IMAGES X3, DANIEL BRIGHT

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POSTMASTER: Send address changes to *BBC Science Focus*, PO Box 37495, Boone, IA 50037-0495.

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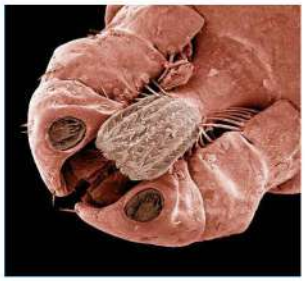

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EYE OPENER

Back at the crib

GREAT BARRIER REEF, AUSTRALIA

It might look like a pool that needs a clean, but it's actually a sliver of hope for the world's coral. The inflatable nursery pictured here is home to larvae that will become the next generation of the Great Barrier Reef, one that's less likely to bleach due to warming oceans.

Parent corals, selected for their resilience to bleaching, release eggs and sperm during annual breeding frenzies. The reproductive cells are collected by marine biologists from Southern Cross University, Australia, who then rear the spawn in 'cribs' – floating enclosures, like this one, anchored to the seabed. After a week, the larvae are released in target areas to replenish the reefs.

"Using natural spawning events like this is a really important way forward to create a future for coral reefs," says Dr Jamie Craggs, co-founder of the Coral Spawning Lab. "By generating new genetic material we hope that some will have long-term climate resilience".

JUERGEN FREUND/NATUREPL.COM

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EYE OPENER

Mammoth meatball

AMSTERDAM,
THE NETHERLANDS

Sink your teeth into this! Australian cultured-meat company Vow has cooked up something truly unique: a meatball made from mammoth meat. Yes, mammoth... the extinct relative of the elephant.

No animals were slaughtered to create this giant – though thankfully, not woolly – meatball. It was grown using sheep cells, into which myoglobin (a gene that encodes for protein) from a mammoth was spliced. Although, as the myoglobin sequence was incomplete, DNA from an African elephant was used to fill in the gaps.

As for how it tastes, nobody can say just yet – the protein is over 4,000 years old, so it must be tested before it's deemed safe for consumption. It's said to smell like crocodile meat, however.

Besides using less land and less water, "cultured meat allows us to create entirely new food experiences," says James Ryall, Chief Scientific Officer at Vow. "

REUTERS

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EYE OPENER

Bat's life

NEW YORK, USA

This ancient bat fossil, found in 2017 and later purchased by the American Museum of Natural History, may be one of the oldest ever discovered.

Named *Icaronycteris gunnelli*, the specimen was found in Wyoming's Green River Formation, a known hotbed of discovery for some of the oldest bat fossils.

"For many years, bat fossils discovered in this formation were assigned to one of two species, depending on their size," said the study's lead Tim Rietbergen. "We had heard rumours about a smaller bat species being present, but it took a while before such a specimen was brought to our attention.

"If we study other Green River fossils in the world's collections, we might find an even higher bat diversity from this location."

Exactly how bats evolved their flying abilities has remained elusive, as the fossil record is sparse. It's thought that bats first evolved their long limbs to climb trees, and evolved to be gliders before eventually becoming capable of powered flight. The fossil record is so incomplete that it remains pure speculation, however. This new find may help researchers to figure out the mystery.

MICK ELLISON/AMNH

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CONVERSATION

YOUR OPINIONS ON SCIENCE, TECHNOLOGY AND *BBC SCIENCE FOCUS*

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LETTER OF THE MONTH

Graham Newton found that sleep headphones eased his insomnia woes

Easy listening makes sleeping easier

The article by Catherine Offord about how it can be hard to get a good night's sleep (February, p66) certainly resonated with me. Up to a few years ago, I slept soundly most of the time. Then I had a number of health and family problems and, of course, there was COVID-19. My sleep deteriorated and I often gave up on bed, instead trying to doze in a chair in the living room. I found that by playing easy-listening music at a very low volume, I tended to drift off and at least get enough sleep to function properly. It seemed that if I focused my mind on the music, I couldn't focus on my problems.

I therefore invested in sleep headphones (a headband with speakers) and tried using the bed again. I now use them every night and drift off to music, rain/waterfall sounds or even an audiobook (the narrator's voice is important). While it's not perfect, most nights I get a decent amount of sleep. The headphones are also useful when on holiday as they block out or reduce most other sounds.

Graham Newton, via email

Those are great suggestions. I often find my mind racing when I instead want to be falling asleep. Like you, I find that sounds of rain – or my favourite: the clickety-clack of a train running quietly along tracks – can help me switch all that off. I've tried audiobooks, but tend to get invested in the plot and end up staying awake to find out what happens next!

Catherine Offord

WRITE IN AND WIN!

The writer of next issue's *Letter Of The Month* wins ***a bundle of the latest hardback science books***. Put pen to paper (or fingertips to keyboard) and you could get your hands on *The One* by Heinrich Päs; *Flight Paths* by Rebecca Heisman; and *We Are Electric* by Sally Adee.

Food for thought

I read your article 'How processed food harms your mood' (March, p66) with great interest and a building sense of alarm. The French study of 26,000 people over five years that showed a significant association between the consumption of ultra-processed foods (UPFs) and developing depression was startling.

It is time we stopped just looking at the physical effects of such food on people, but also at what it does to their mental health. Above all, we need encourage parents to reduce the amount of UPFs they feed to their children. Otherwise, we'll be facing a ticking timebomb of mental health issues that's bigger than the one we're already facing.

Natasha Russell-Carr, Wakefield

Cats vs dogs!

I'm sorry to disappoint Chris Stracey (March, p12). The face he saw in the image of Earth is a lioness not a dog. Thanks for a great mag.

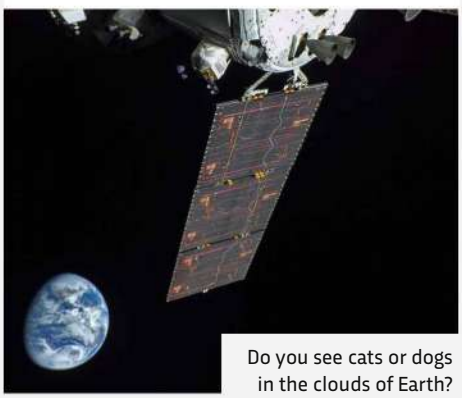
Thomas Jones, via email

Checking back after reading Chris Stracey's letter in the March issue, I noticed the two Pekingese watching a Labrador eat the clouds!

Heather Weeks, via email

Eyes on the back of your head

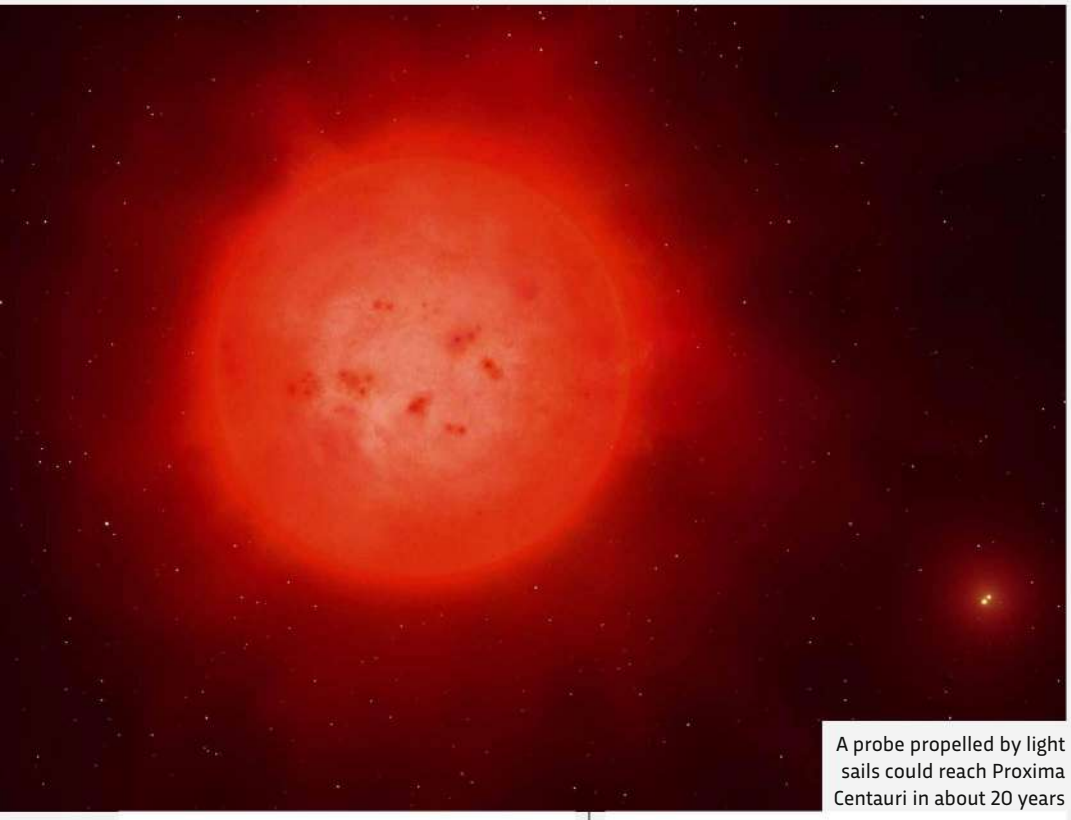
The Q&A question 'Am I psychic?' (February, p81) was of interest to me because I too have experienced the staring phenomenon. Since



Do you see cats or dogs in the clouds of Earth?

"THE STARTING PLACE IS TO FLIP WHAT HAS BEEN A SYSTEM THAT FAVOURS CORPORATIONS OVER INDIVIDUALS, GIVING PEOPLE A RIGHT TO THE DATA FROM THEIR BRAINS"

PROF NITA FARAHANY, P44



LLNL, GETTY IMAGES, NASA/JSC

A probe propelled by light sails could reach Proxima Centauri in about 20 years

I was a teen, I've often looked at the back of people's heads only to have them turn around and look at me. Sometimes I'm just wondering what they look like, other times I'm not thinking anything. Either way it's embarrassing, since I always turn red, even now at age 80. If the subject comes up, I tell people that "I think too loudly!" Believe me, it happens much too often to be random.

Kirk Lovenbury, Williamsburg, VA, USA

Set sail to the stars

A letter on your *Conversation* page (February, p13) said that a lightweight probe would take 70,000 years to reach Proxima Centauri "with our existing space technology". That may be true but light sail technology is proven, and an array of megawatt lasers could accelerate a light sail craft to an appreciable percentage of the speed of light – perhaps 20 per cent as envisioned in the Breakthrough Starshot initiative proposed by Yuri Milner and Stephen Hawking. This could reduce the time required to about 20 years.

Malcolm K Cleaveland, Professor Emeritus of Geosciences, University of Arkansas

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Managing editor Alice Lipscombe-Southwell
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Staff writers Alex Hughes, Holly Spanner

ART
Art editor Joe Eden
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CONTRIBUTORS
Stephon Alexander, Adrian Arias Astorgano, Amy Arthur, Rob Banino, Peter Bentley, Steve Boswell, Sam Brewster, Daniel Bright, Dean Burnett, Kate Darling, Emma Davies, Russell Deeks, Liam Dutton, Pete Etchells, Elena Galafaro Bansh, Alastair Gunn, Valentina Hernandez Gomez, Matt Holland, Christian Jarrett, Stephen Kelly, Pete Lawrence, Jason Lyon, Nish Manek, Harriet Nobel, Kelly Oakes, Stephanie Organ, Ezzy Pearson, Helen Pilcher, Andy Potts, Louisa Preston, Catherine Regan, Ginny Smith, Joe Waldron, Giles Yeo.

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Head of apps and digital edition marketing Mark Summerton
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Audit Bureau of Circulations 70,284 (combined, Jan-Dec 2022)

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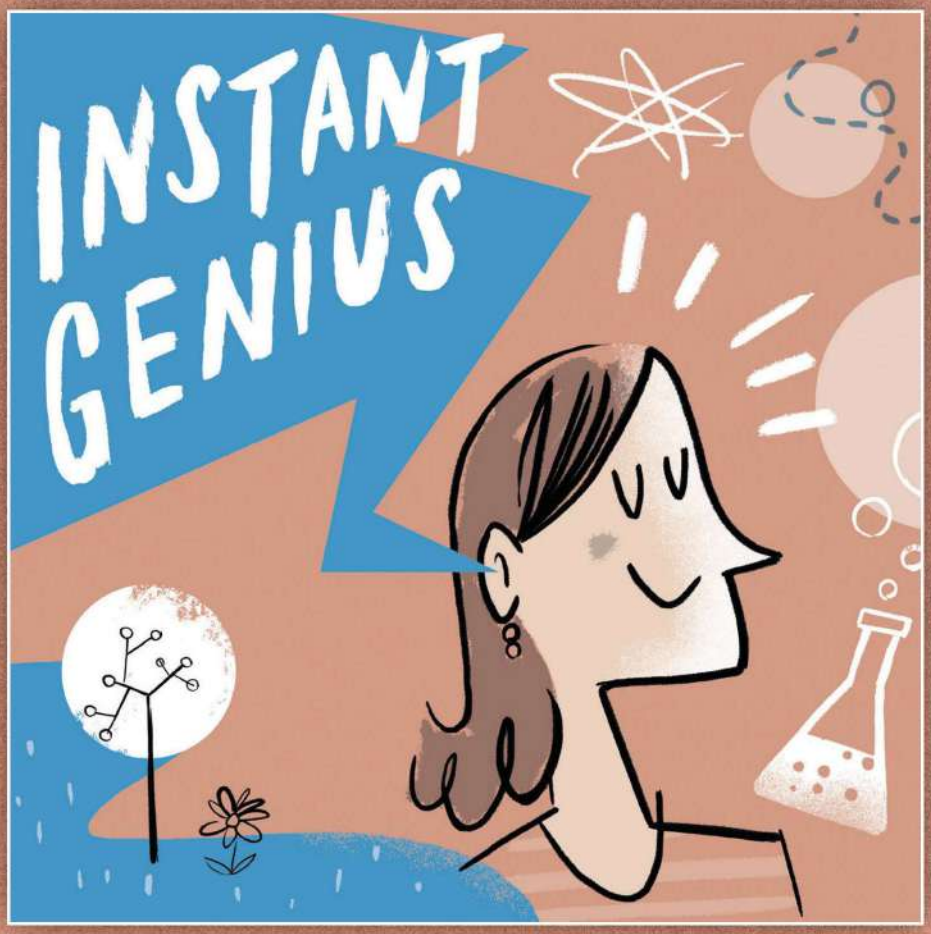

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with ***Prof Lars Chittka***

LIFE ON MARS
with ***Lewis Dartnell***

ARTEMIS
with ***Libby Jackson***

DISCOVERIES

"These brave four will kickstart our journeys to the Moon... and beyond"

Norm Knight, director of flight operations, NASA **p22**

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Turns out your body has a way to defy the sands of time **p16**

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The white stuff was vital for early humans living in Tibet **p20**

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Meet the crew of NASA's Artemis 2 mission **p22**

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CARTWHEELING SNAKES

As if the slithering reptiles weren't scary enough already **p23**

If all goes according to plan, two of these four astronauts will be the next humans to set foot on the Moon

NASA/JSC

GERONTOLOGY

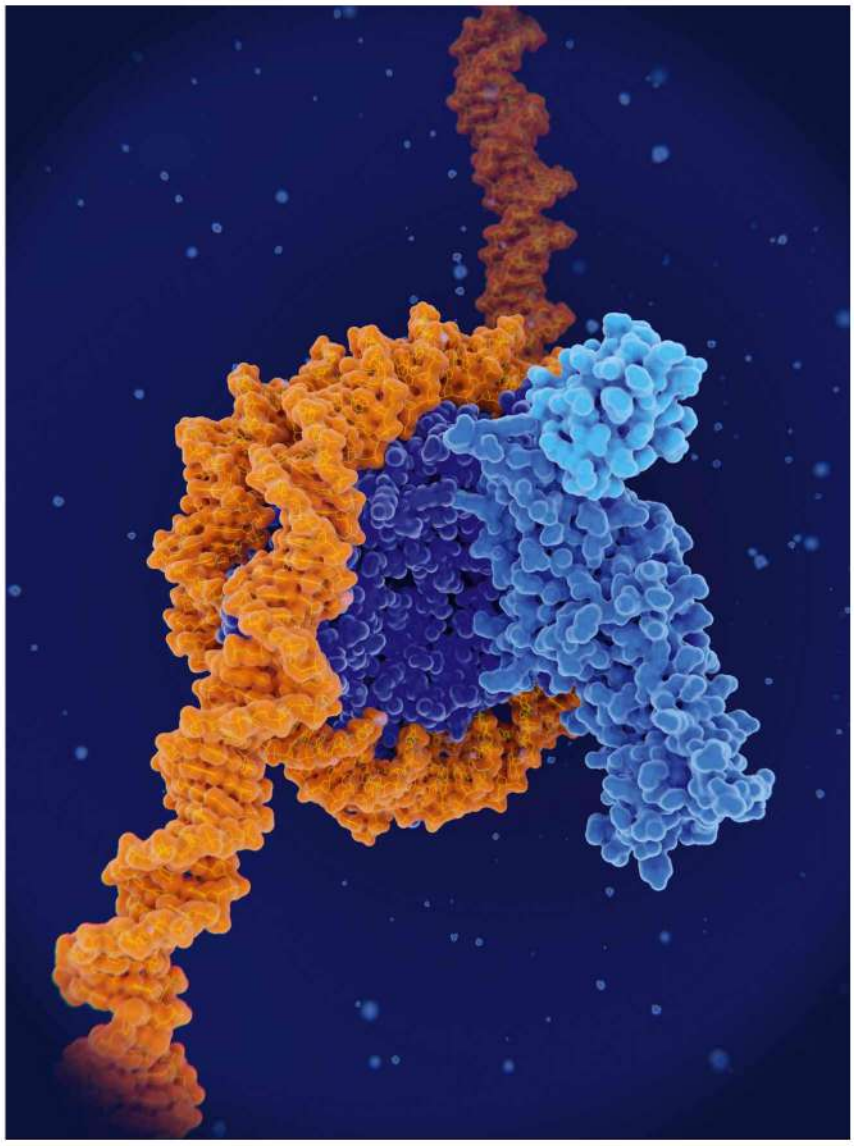
SCIENTISTS DISCOVER NATURAL ANTI-AGEING MECHANISM IN HUMANS

Time is driving your age forwards, but a new study suggests you can slow it down... and maybe even reverse it

Humans can effectively de-age after recovering from stressful events, a new study from Harvard Medical School and Duke University School of Medicine has found. The study shows that while stress can age a person biologically, the body can reverse this effect.

While chronological age represents the number of years you've lived, biological age is defined by how much your DNA has been altered by a chemical reaction called methylation (loosely speaking, a process that turns genes off). Your biological age is influenced by factors like disease, lifestyle and environmental exposure. Stress, whether physical or mental, has also been found to

ABOVE Based on your ability to deal with stress, you may be older, or even younger, than your age suggests



ABOVE Methylation sees proteins (in blue) that are produced by stress cause changes in the body's DNA (orange) to increase its biological age

ABOVE RIGHT Dr Vadim Gladyshev was one of the senior authors of the study that found the body is able to slow its biological ageing

GETTY IMAGES X2, HARVARD CANCER CENTER

"The ability to recover from stress may be an important determinant of successful ageing"

rapidly age a person biologically.

The study, published in *Cell Metabolism*, shows that your biological age is more flexible than your chronological age. In fact, people can be biologically older or younger than their chronological age. The researchers say that the discovery that biological age is "fluid, fluctuating and malleable" questions the long-held belief that it can only increase, like chronological age.

The study tested the idea that methylation levels change predictably during biological ageing as they do for chronological ageing. But the researchers found that participants' methylation levels differed from the predicted levels for their chronological age.

Methylation from severe stress increases mortality (your likelihood of death) as a higher biological age increases your susceptibility to stress-related diseases. This study shows that reversing your biological age can decrease your mortality. The study's co-senior author Dr Vadim Gladyshev said this suggests that "the ability to recover from stress may be an important determinant of successful ageing and longevity" – or how well we grow old.

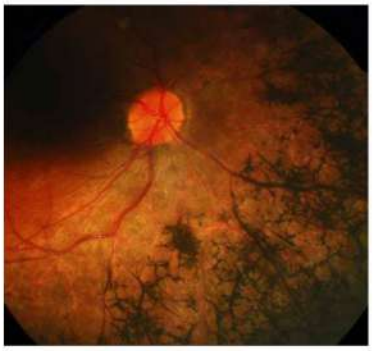
In the future, your biological age may become a useful measure of your stress levels and how well you have recovered from them.

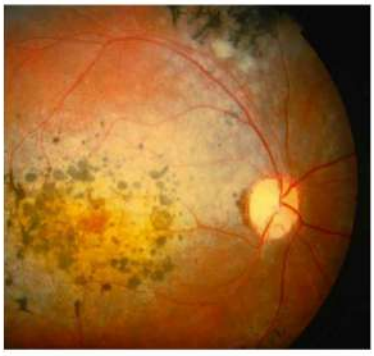
As the study shows that our bodies are able to induce this reversal naturally, it provokes questions as to whether we might be able to reverse our age beyond the recovery baseline.

MEDICINE

NEW OMEGA-3 OIL COULD FEND OFF SIGHT LOSS DUE TO ALZHEIMER'S OR DIABETES

Initial studies in mice have been highly successful





ABOVE Retinas afflicted with pigmentary retinopathy, an eye disease that leads to sight loss. The dark areas are photo-receptor cells that have degenerated

SCIENCE PHOTO LIBRARY X3, UNIVERSITY OF QUEENSLAND

A new form of the fatty acid omega-3 could help to stave off the deterioration in vision related to Alzheimer's disease, diabetes and several other disorders, researchers at the University of Illinois at Chicago have found.

In healthy eyes, an omega-3 fatty acid called docosahexaenoic acid (DHA) helps to maintain photoreceptors – specialised neurons that convert light into electrical signals that are sent to the brain via the optic nerve – in the retina. Patients with Alzheimer's disease, diabetes, age-related macular degeneration and several other disorders have low levels of DHA, which often results in sight loss.

The form of DHA commonly found in omega-3 fish oil supplements is the closely related triacylglycerol DHA, or TAG-DHA. However, this form can't pass from the bloodstream to the retina. As a result, "increasing the retinal DHA at clinically feasible doses hasn't been possible until now," said Sugasini Dhavamani, a research assistant professor in the Department of Medicine at the University of Illinois at Chicago.

In a series of studies carried out on mice, the Chicago researchers developed a novel form of DHA known as lysophospholipid DHA, or LPC-DHA, that can be more readily absorbed by the retina and help to combat sight loss. The researchers found that mice bred to show similar symptoms to those found in people with early-onset Alzheimer's showed a 96 per cent increase in retinal DHA after six months of being fed a daily LPC-DHA supplement.

In contrast, supplements containing TAG-DHA given over the same time period had no effect on retinal DHA levels. "This study uses the novel approach of dietary LPC-DHA that overcomes both intestinal and blood–retinal barriers and improves retinal function," Dhavanmani explained.

The dosage used in the study was equivalent to about 500mg for humans – similar to the amount of TAG-DHA commonly found in omega-3 fish oil capsules. However, further studies would be needed to confirm whether LPC-DHA is safe and effective for use in humans, the researchers say.

ENVIRONMENT

THESE RAVENOUS CRABS COULD HELP SAVE THE GREAT BARRIER REEF... BY EATING STARFISH

The crustaceans could be introduced to reefs threatened by proliferations of starfish

Red decorator crabs could help to save the Great Barrier Reef from coral-crunching starfish by eating them for lunch, according to a study carried out at the University of Queensland.

The Great Barrier Reef is the world's largest coral reef system and the largest single structure made by living organisms on Earth. It's made up of 2,900 individual reefs spread over nearly 350,000km².

Crown-of-thorns starfish (COTS) feed on coral. They can grow to 45cm in diameter and can eat up to 10m² of coral a year. Under normal circumstances, they're a healthy part of the reef's ecosystem but when they proliferate they can become a serious problem.

ABOVE Red decorator crabs have a seemingly insatiable hunger for crown-of-thorns starfish

Not all reefs experience proliferation, however. The team suspected that this was due to certain predators feeding on COTS and controlling the populations.

To test this theory, they placed juvenile COTS in tanks along with more than 100 species of crabs, shrimps, worms, snails and small fishes, and observed their feeding behaviour over several days. They found that the red decorator crab that dwells in coral rubble on the seabed was particularly ravenous.

"The red decorator crab was by far the most consistent predator, consuming COTS in 89 per cent of the feeding trials," said PhD candidate Amelia Desbiens from the University of Queensland's School of Biological Sciences.

"We were surprised by its voracity – each red decorator crab devoured more than five COTS per day, while most other species barely ate a single one. It's one of the best predators of COTS we've seen and could be a natural buffer against future outbreaks [of them] on the reef. Few animals successfully eat adult COTS but they're vulnerable when young because they're small and lack toxic spines to defend themselves. COTS are mass-reproducers and can develop into large populations, so it's vital we find a way to deal with outbreaks quickly."

The team now plans to conduct widespread surveys of the Great Barrier Reef to gain a better understanding of the distribution of red decorator crabs and to see if their presence can prevent COTS outbreaks in the wild.

GREAT BARRIER REEF FACTS

The Great Barrier Reef is the world's most extensive expanse of coral reefs, and is home to 400 species of corals across 60 genera.

Almost 10 per cent of the world's total fish species can be found within the Great Barrier Reef – that's more than 1,600 species.

The Great Barrier Reef is one of the Seven Natural Wonders of the world and became a UNESCO World Heritage Site in 1981.

ANTHROPOLOGY

DAIRY WAS ESSENTIAL TO THE SURVIVAL OF ANCIENT HUMANS IN EXTREME ENVIRONMENTS

For ancient humans looking for a new home, a dietary change made a move to the Tibetan highlands possible.

Dairy consumption was crucial to the survival of ancient humans in one of the world's most inhospitable environments at least 3,500 years ago, according to new research at the Max Planck Institute of Geoanthropology in Germany.

Archaeologists at the Institute used a new tool called palaeoproteomics to locate milk proteins in the dental remains of ancient skeletons, and the prevalence of milk consumption on the highland Tibetan Plateau surprised the researchers. Examining 40 individuals across 15 sites on the plateau, they found that all skeletons belonging to milk drinkers had been recovered from locations sitting more than 3,700m above sea level – with the highest dairy consumer found at a dizzying altitude of 4,654m.

These sites are in the northern and western part of the vast plateau where crop growing is difficult, making them tough places for humans to survive. The adoption of a dairy diet complemented existing evolutionary adaptations to high altitudes in early Tibetans, enabling occupation of the Tibetan Plateau's highlands, which are so harsh and resource-poor they are often known as the 'third pole'. No milk drinkers were found in the southern areas of the plateau where land is more farmable.

The findings follow an "incredibly clear pattern," said the paper's lead author Li Tang. They show that milk was key in helping those in higher areas survive, as grazing animals could now "convert the energy locked in alpine pastures into nutritional milk and meat" that allowed the Tibetan pastoralists to thrive.

ALAMY, LI TANG, TEL AVIV UNIVERSITY

WHAT IS PALAEOPROTEOMICS?

Palaeoproteomics is a means of analysing ancient tissues, from bones and teeth to softer materials such as skin and hair. It involves using mass spectrometry to calculate the exact mass of the molecules within a sample. The tool provides extraordinarily detailed results – in this case, showing not only which individuals consumed milk and which did not, but also what species the milk had come from (mainly goats and sheep).

Prior to the emergence of palaeoproteomics, archaeologists had to rely on analysing animal remains and food containers, which provided limited evidence of milk consumption.

OPPOSITE Drinking milk may have helped Tibetans survive in harsh climes

ABOVE Dental remains can tell a story about diet

Tang told BBC Science Focus that the team behind the study, published in the journal Science Advances, are also in the process of analysing plant proteins in the same individuals' dental calculus (hardened dental plaque), in a bid to discover what other types of food featured in their diets.

"This is a very neat study that clearly demonstrates human ingenuity in using technology – in this case, dairying – into ways to survive in new environments," said Dr Brenna Hassett, a bioarchaeologist at University College London. "The information locked in dental calculus has quite a bit more to reveal about human life in the past."

BOTANY

PLANTS SCREAM WHEN WE FORGET TO WATER THEM

They sound a bit like bubble wrap being popped

Biologists from Tel Aviv University have found that plants emit sounds comparable in volume to normal human conversation when they are stressed. With frequencies of 20-100kHz, these sounds are too high-pitched for humans to hear, but it is likely they can be heard by insects and perhaps by other mammals, the researchers say.

"Even in a quiet field, there are actually sounds that we don't hear, and those sounds carry information," said senior author Prof Lilach Hadany, an evolutionary biologist based at Tel Aviv University.

The researchers recorded the sounds made by tomato and tobacco plants using regular microphones, placing the plants in a soundproofed acoustic chamber and then later in a noisy greenhouse. In both situations they stressed some of them first, by not watering them for several days or by cutting into their stems.

After recording the plants, the researchers trained a machine learning algorithm to analyse the difference in the sounds produced by unstressed, thirsty and cut plants. They found that stressed (thirsty or cut) plants produced around 30 to 50 high-pitched clicks or pops per hour at random intervals, while those that were unstressed produced far fewer clicks in the same period.

It is possible that other plants and animals are 'listening' to this information. According to Hadany, "other organisms could have evolved to hear and respond to these sounds. For example, a moth that intends to lay eggs on a plant, or an animal that intends to eat it, could use the sounds to help guide their decision."

What's more, the machine learning algorithm was able to identify the different types of sounds produced depending on the cause of stress – and also which plant they came from.

It's not yet clear exactly how the plants are producing these sounds, though the researchers suggest that it might be due to the formation and bursting of air bubbles inside the plants.

ABOVE Forget talking to plants: the question is, are they talking to us?

SPACEFLIGHT

TWO OF THESE ASTRONAUTS WILL BE THE FIRST HUMANS TO STEP ON THE MOON SINCE 1972

The crew of four will conduct the final test flight in NASA's Artemis programme towards the end of next year

On 3 April, NASA announced the names of the four astronauts who will crew Artemis 2, in preparation for the first Moon landing in over 50 years. The crew, formed of three NASA astronauts and one astronaut from the Canadian Space Agency, includes the first woman and the first African American to be assigned to a lunar mission.

Following the success of the uncrewed Artemis 1 mission in November 2022, Artemis 2 is scheduled for launch in late 2024. Its crew will be formed of astronauts Christina Koch, Victor Glover and Reid Wiseman from NASA and Jeremy Hansen from the Canadian Space Agency (CSA). The four astronauts will attempt to complete a lunar orbit aboard NASA's Orion capsule and then return to Earth.

If Artemis 2 is successful, Artemis 3 will launch as soon as 2025 and see two of these four astronauts spend a week on the Moon while the other two remain in lunar orbit. After Artemis 3, NASA plans to launch crewed missions once a year and establish a permanent Moon-orbiting space station called Lunar Gateway as a stepping-stone towards future missions to Mars.

"I could not be prouder that these brave four will kickstart our journeys to the Moon and beyond," said NASA's director of flight operations Norm Knight. "They represent what an astronaut corps should be: highly capable and accomplished individuals with the skills and determination to take on any trial as a team."

The mission will see the astronauts lift off from Kennedy Space Center before an approximate travel time of four days to the Moon. The crew will then conduct a 'lunar flyby' – an orbit of the Moon without landing – before the four-day return journey. The mission will end with re-entry into Earth's atmosphere and recovery after splashdown into the Pacific Ocean.

THE ARTEMIS 2 CREW

REID WISEMAN (NASA)
Age: 47
Wiseman is a decorated naval aviator. He was selected for NASA's 20th astronaut class in 2009 and recently served as Chief of the Astronaut Office.

JEREMY HANSEN (CSA)
Age: 47
Hansen is the Canadian Space Agency's representative on the crew. He became an astronaut in 2009 but this will be his first spaceflight.

CHRISTINA KOCH (NASA)
Age: 44
Holds the record for the longest single spaceflight by a woman after spending 328 days as flight engineer on the International Space Station.

VICTOR GLOVER (NASA)
Age: 46
Glover is a naval aviator who completed his first spaceflight in 2021. He has spent 168 days in orbit and participated in four spacewalks.

ZOOLOGY

THINK SNAKES ARE SCARY? WHAT IF THEY CAN SOMERSAULT?

Dwarf reed snakes can cartwheel away from predators

For the first time, a cartwheeling motion that is exceptionally rare in vertebrates has been observed in a snake species and reported in a study published in the journal *Biotropica.*

The dwarf reed snake (*Pseudorabdion longiceps*) is a nocturnal reptile that spends most of its time hiding in leaf piles or under rocks and logs. However, as the new study explains, in the face of danger it can perform a rare escape manoeuvre. When threatened, the snake pulls its coils into an S-shaped loop before using its tail to push off the ground – throwing its body forward in a repeated 'recoil-and-roll' manoeuvre to create a cartwheeling motion.

During the study, scientists recorded one snake cartwheeling a distance of 1.5m in under five seconds. The researchers believe the snake may also perform the cartwheels to startle and confuse predators – as an acrobatic distraction that creates crucial time for it to bid a hasty retreat.

Fortunately for anyone with a fear of snakes, you probably won't see a dwarf reed snake somersaulting towards you if you live in Europe or the Americas. The reptiles are mainly based in southeast Asia, ranging from southern Thailand and Singapore to Borneo and its surrounding islands.

While there have long been anecdotal accounts of the cartwheeling dwarf reed snake, this study by the Association of Tropical Biology and Conservation marks the first time such movement has been formally documented in this or any other snake species.

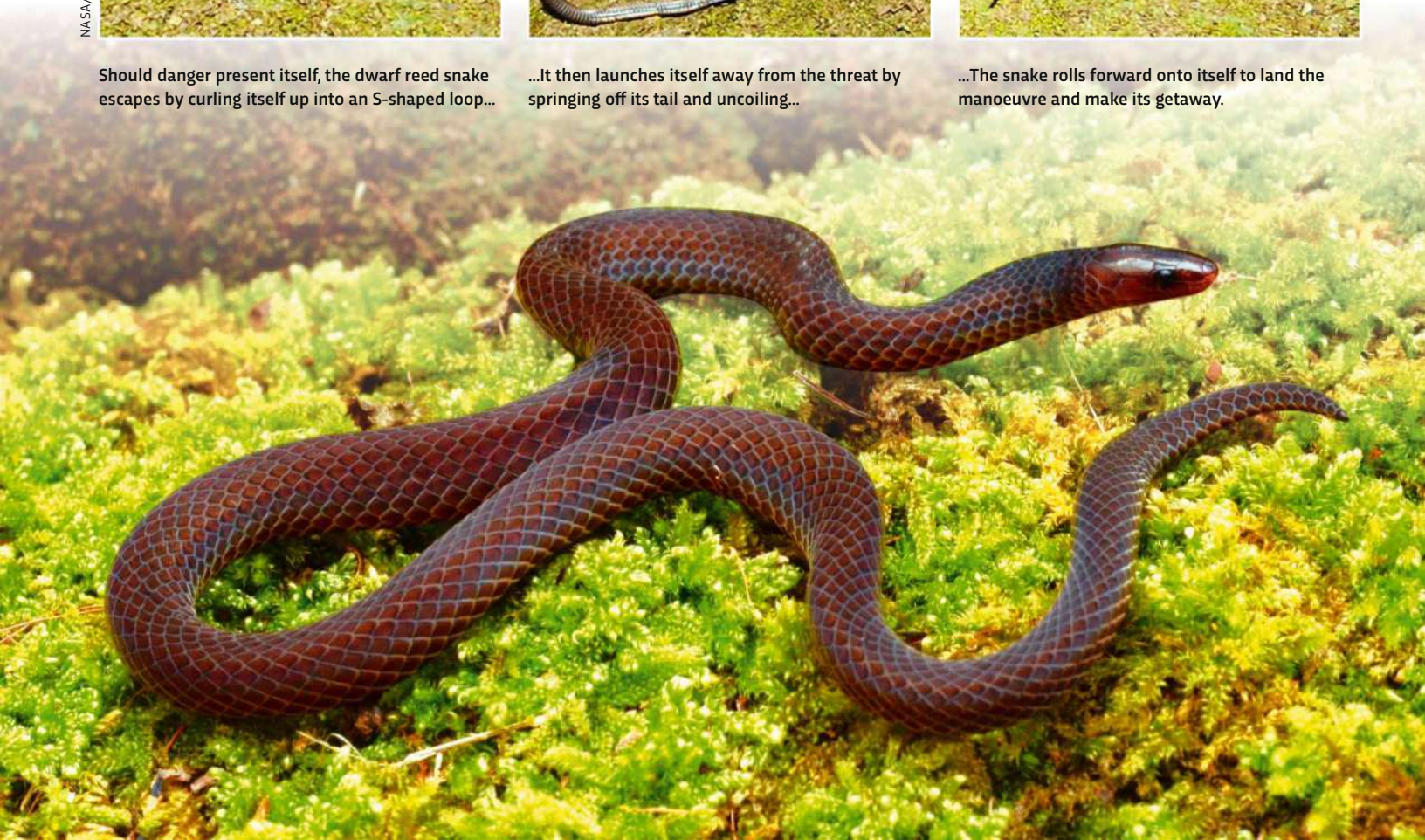
According to the paper, small snakes have a range of typical defence mechanisms that include fleeing, camouflage, odours, intimidation and playing dead. The authors of the study believe that there may be other small snakes that cartwheel – especially those within the same family as the dwarf reed snake – but note that observing these species can be difficult given how reclusive they are.

NASA/JSC X4, EVAN S H QUAH/WILEY X4

Should danger present itself, the dwarf reed snake escapes by curling itself up into an S-shaped loop...

...It then launches itself away from the threat by springing off its tail and uncoiling...

...The snake rolls forward onto itself to land the manoeuvre and make its getaway.



PRIMER

LOW-CARBON HOUSES

A window maker is shedding light on how to build greener homes

The building industry accounts for an astonishing 37 per cent of global carbon dioxide emissions. To address this, the roof-window specialists VELUX recently launched Living Places Copenhagen: an open-source "experimental living environment". The seven prototype buildings, including community pavilions and two homes, are designed to reduce environmental impact and improve human health – and have a carbon footprint that's a third lower than the equivalent conventionally constructed buildings. But how is this possible? We spoke to Lone Feifer, Director for Sustainable Buildings for VELUX, to find out more.

THE MATERIALS USED TO BUILD THE HOUSES ARE SOURCED LOCALLY. DOES THAT PLAY A BIG PART IN REDUCING THEIR CARBON EMISSIONS?

There are many phases in a building's full lifecycle, including the extraction of the materials, transport, construction, operations and end of life. The transport phase isn't actually that significant in terms of carbon emissions. But there are other reasons for using local materials. In many ways, a lot of today's housing is very generic, like cookie-cutter houses. In the project we wanted to make something that has a vernacular.

If you look at how houses were built in the past, they were constructed using materials that matched their location. Houses near the coast, for example would be built with wind, salt and other climatic conditions in mind. But we seem to have forgotten that and put housing up according to a strict form and recipe.

It's also about access: there are no materials used in the Living Places houses that you couldn't buy at a local DIY shop today.

WHY DID YOU CHOOSE TO USE TIMBER IN THE HOUSES?

Timber has several advantages: it's less resource-draining than concrete and it can be made as fireproof as a concrete building. It's also a renewable resource, and a condition of certified forestation is that you plant another tree when you take one. But a less technical advantage of timber is that we can relate to it. I think it's because timber has cells like we do, and that it'll expand and breathe with humidity and temperature.

WHAT SURPRISED YOU DURING THE THREE-YEAR PROCESS OF DEVELOPING THESE HOUSES?

The key surprise was how far the architects and engineers discovered they could go when working together. We talked to another project that's also trying to innovate and get their carbon footprint as low as possible but they did the classic thing of separating their process into the architect doing the design, sending it to the engineer, who sends it to the developer or contractor. We put them all together and they learned so much through discussions and challenging each other, such as finding that you can use natural ventilation rather than mechanical.

IS THERE SCOPE FOR THIS MODEL TO BE INTEGRATED INTO THE WIDER BUILDING INDUSTRY?

That's the ambition. We specifically made the buildings as a concept because we want to be able to share the recipe with others. We've done over three years of work and have come out with a tried-and-tested prototype, but the next step is to build it at scale. A key part of this means providing all of our data to housing developers so that they can test changes to materials, such as different cladding or an alternative foundation.

HOW MUCH WILL THESE HOUSES COST, AND ARE THERE PLANS TO CREATE HOMES LIKE THESE IN OTHER COUNTRIES?

They cost same as standard housing in Denmark. What will cost more is for the builder to make yours different but we have eliminated the risks and

VELUX was able to reduce the carbon footprint of its seven prototype buildings by scrutinising the materials and construction methods

VELUX GROUP

answered the ‘what if’ questions. We’re already working with people in the UK and Germany on realising the Living Places concept, including a developer who plans to build both row houses [terraces] and a multi-family four-storey unit by 2024.

HOW CAN WE APPLY THESE CONCEPTS IN OUR OWN, EXISTING HOMES?

Most future housing is already here. The best thing we can do in terms of sustainability is to maintain the homes we’ve built, care for them and keep them going.

Your health is the biggest investment in any home. Avoid humidity and act on mould. Bring in good-quality air and enough light so that your body clock works effectively and you sleep well at night. There’s a German word, Stoßlüften, for opening your windows at a certain time of the day to ventilate your house. The COVID-19 pandemic changed our whole understanding of ventilation and how important it is: having good-quality air is conditional to our health and wellbeing.

WHAT IS IMPORTANT IN BUILDING A GOOD HOME?

Part of the design task is identifying the functions you need and the size you need them to be – while using fewer resources and less space. You also need community – the places where you can have a big family dinner and meetings with friends. This was also obvious during the pandemic: a sense of community and knowing your neighbours is an essential part of belonging. That’s why we built the seven ‘shapes’ including community buildings – not just the one house. It all comes back to the idea that if you feel at home, you will like your house and take care of it.

LONE FEIFER
Lone is an architect and the director of Sustainable Buildings at the VELUX group.

SPACE

LIFE ON MARS: STEP INSIDE THE HABITAT THAT'LL BECOME NASA'S MARTIAN BASE

NASA has tried to make things as real as possible for the crew taking part in this simulated mission

This June, four volunteers will begin a year-long simulated Mars mission, and what you see here is the 3D-printed 'habitat' they'll call home. The 518m² Mars Dune Alpha habitat sits within a white warehouse at NASA's Johnson Space Center in Houston, Texas; a warehouse that's been redecorated to resemble the red planet, complete with red mountains on the 'horizon' and red sand underfoot.

The crew will go about their daily lives as though they're stationed on Mars, growing their own food, conducting experiments and completing mission-specific tasks, including using a large sandpit for spacewalks (or 'Marswalks').

The volunteer crew, made up of civilians with expertise in research science, engineering and medicine, will be locked in during the simulation so that NASA can test the effects of isolation on their health and performance. They'll also face challenges such as resource limitations, communication delays and equipment failures.

"Ultimately, this will help NASA make informed decisions to design and plan for a successful human mission to Mars," said Dr Grace Douglas, the mission's principal investigator. A real human mission could see people living on the red planet for as long as two and a half years.

1

1. The 'landscape simulation area' contains instruments and equipment that will be used during actual missions on the Red Planet.

2. Mars Dune Alpha's lounge is complete with items to keep the crew entertained during downtime, including the board games *Catan: Starfarers* edition and *Monopoly*, as well as a PlayStation 3 and a Super Nintendo console.

3. The future of extra-terrestrial construction, 3D printing requires few building materials that can't be found on Mars, thus eliminating the need for NASA to spend money and energy launching heavy construction materials into space.

4. A cement-based mix is used to form the simulated habitat, although a real one is likely to use ingredients found on the Martian surface. The simulated habitat has a layout that contains four private living quarters, work stations, a medical station, lounge, and food growing stations.

REUTERS X2, ICON X2

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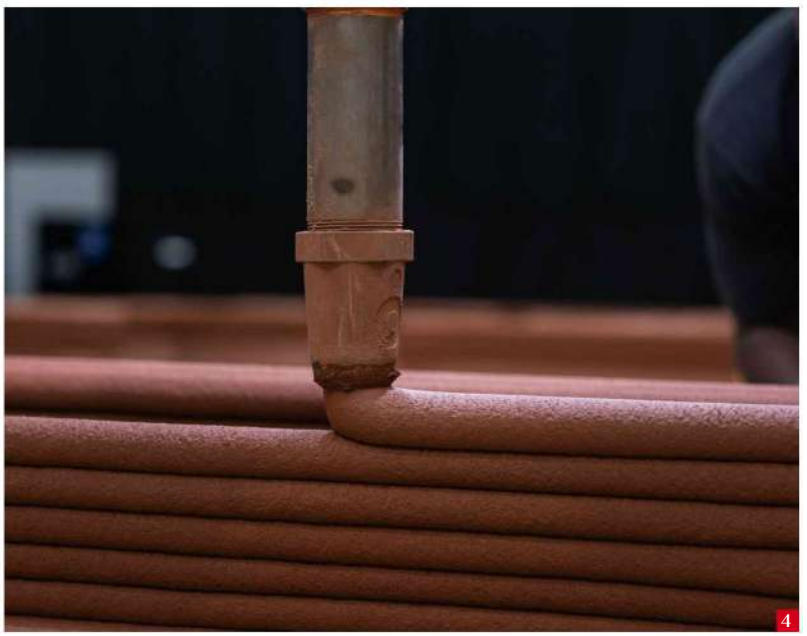
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COMMENT

WHY EVERYTHING YOU KNOW ABOUT WEIGHT LOSS IS WRONG

When it comes to fat, there's no 'one-size-fits-all' approach

Recently, I was interviewed by Steven Bartlett on the *Diary Of A CEO* podcast about my work on obesity. While I've done a gazillion previous podcasts, either as host or guest, this one stood out for three reasons: first, the interview was long-form and was released in its entirety; second, in addition to the audio recording, it was filmed with multiple cameras, and posted online; and third, the scale of the audience. I'm not sure how many listeners tuned in to the actual podcast, but at time of writing, 2.5 million(!!) people had viewed the 'feature-length' interview on YouTube.

What soon became clear was, of the millions that watched, many felt the need to comment loudly on social media (while tagging and @-ing me) on my appearance, vis-à-vis my expertise in obesity. I am, shall we say, not at my 'fighting weight', having gained more than four kilos during the past few COVID years. This, coupled with my sartorial error of appearing in a roll-neck sweater (although in my defence I was not expecting to be filmed), resulted in comments like, "Why would you trust a man with moobs about weight and nutrition?" Ouch.

This got me thinking, though. If I, a slightly squashy middle-aged professor, was on the receiving end of such comments, what horrors must someone with obesity be facing on a daily basis? It is interesting that if I were to negatively comment on someone's gender, sexual orientation or ethnicity in public, I would rightly lose my job. Yet today, many feel it appropriate to comment on someone's size or shape. Weight stigma is rife. It's not only cruel, but counterproductive, yet ubiquitous in society. It has led to the emergence of the body-positivity movement.

'Body positivity' was founded on the belief that all of us should have a positive body image, and advocates the acceptance of all bodies, regardless of physical ability, size, gender, race or appearance, and I understand its emergence as a protest to 'fat-shaming'. I fear, however, that some have gone too far with regards to the 'health at every size' messaging, and are ignoring the science. What is unequivocal, and please don't shoot the messenger, is that carrying too much fat is bad for your health.

So why is carrying too much fat bad? In large part, people misunderstand what happens when they gain or lose weight; they think that they are gaining fat cells or losing fat cells. This is not true. You have to consider your fat cells like balloons; they get bigger when you gain weight, and smaller when you lose weight. The actual number of fat cells doesn't change by much. The safest place to store fat is in fat cells. Like balloons, fat cells will expand until they can't expand any more. This is when the trouble begins, because once our fat cells are full, the fat has to go somewhere else, and ends up in our muscles or our liver, for example. While these are designed to store some fat, too much of it begins to adversely affect their function, in a phenomenon known as 'lipotoxicity', literally meaning fat poisoning. Thus, when we are carrying more fat than we can safely store, that is when we tilt into diseases such as type 2 diabetes, heart disease and certain cancers.

But how much is too much fat? Here is the interesting thing: depending on our biology, our fat cells are able to expand to different sizes before becoming full. So East Asians (such as Chinese folk like me) and South Asians (such as Indians, Pakistanis and Bangladeshis) don't have to put on that much weight before increasing their risk of getting type 2 diabetes. Whereas others, including white people and, famously, Polynesians, can gain a lot more weight before becoming ill, in large part, due to the expandability of their fat cells.

The degree to which our fat cells can expand has powerful genetic influences and informs our differing safe fat-carrying capacities. So there is most definitely health present at many sizes, with some larger folk being metabolically healthy, and lean people with type 2 diabetes. But here is the critical take-home message: for any given individual, there cannot be health at every size, because if you surpass your own safe fat-carrying capacity, you WILL become ill. I am not saying this to be body negative, and I am certainly not judging or blaming anyone who chooses not to lose weight, or who has tried and been unsuccessful. I am simply stating a crystal-clear biological fact.

In a mature society, we should be able to hold two thoughts in our head simultaneously; that living with obesity is not healthy, and those with obesity are not to blame. The ability to someone's safe fat-carrying capacity is the subject of genetic and biological research, and would transform the way we consider the definition of 'obesity' and who actually needs to lose weight.

PROF GILES YEO
(@GilesYeo)
Giles is a professor of molecular neuroendocrinology at the University of Cambridge, whose research focuses on food intake, diabetes and obesity. His latest book is Why Calories Don't Count *(£14.99, Orion Spring).*

"For any given individual, there cannot be health at every size"

ILLUSTRATION: HARRIET NOBEL

extra weight

ILLUSTRATION: ADRIAN ARIAS ASTORGANO

COMMENT

ROBOTS AREN'T COMING FOR YOUR JOB... THE SYSTEM IS

Artificial intelligence could change the face of many industries, but it'll be humans that decide how

Shortly after ChatGPT was released, in early 2023, a freelance writer named Jason Colavito posted on social media that a client was replacing him with AI, because it could write content for free. But the client also wanted to hire Colavito – at a fraction of his normal rate – to 'rewrite' the AI-generated text. This is not the first time that technology has slashed salaries instead of jobs, and the real problem is not AI. The problem is a culture that devalues human labour.

With the release of new AI applications, discussions about the future of work are resurging in full force. A recent study looked at professions in the United States, from poets to financial managers, predicting that 19 per cent will soon lose 50 per cent of their tasks to AI. But our previous experience with automation suggests it's much more complicated than technology simply replacing human work.

"The deskilling and devaluing of labour isn't because the robots are coming for us – it's cultural"

DR KATE DARLING
(@grok_)
Kate is a research scientist at the MIT Media Lab, studying human-robot interaction. Her book is The New Breed *(£20, Penguin).*

In 2019, independent research organisation Data & Society studied how automation is being integrated in farm management and grocery stores. Counter to the popular belief that the technology was reducing the need for human labour, researchers Alexandra Mateescu and Madeleine Clare Elish discovered that introducing new devices was mostly changing the nature of the work. For example, automated checkout machines kept employees busy, because now they were assisting confused customers, troubleshooting machines, and taking on other tasks to ensure their smooth operation in the store. Most importantly, Mateescu and Elish discovered that the new tasks, which helped accommodate and implement the 'automated' technology, were often undervalued or even invisible.

Writer and filmmaker Astra Taylor calls this phenomenon 'fauxtomation'. In her article *The Automation Charade*, she points to lost jobs and cut salaries where technology is introduced, despite the fact that people are still doing work around the machines. Whether it's the customer scanning their own biscuits at the self-checkout, or the employee saving a robot that's stuck in the parking lot, the new work is often deskilled, declared less valuable, or unpaid entirely.

We're a far cry from being able to sit back and sip tea while the robots do work for us. In fact, we may experience the opposite. In *More Work For Mother: The Ironies Of Household Technology From The Open Hearth To The Microwave,* historian Ruth Cowan documented how household labour (which remains invisible and unvalued) paradoxically increased with the introduction of 'labour-saving' devices like dishwashers and vacuum cleaners, because it also raised productivity and cleanliness standards.

Similarly, people may need to work more, not less, with more automation. For example, media professor Ian Bogost predicts that AI technologies like ChatGPT will end up creating more bureaucratic burden than actually saving effort. Over the past years, we've already seen warehouse workers follow timelines set by algorithms that penalise them for bathroom breaks, and drivers being squeezed like lemons in the app-enabled gig economy.

Meredith Whittaker, co-founder of research institute AI Now, and president of non-profit organisation Signal, summed up the good and bad news about the future of work when she commented on Colavito's freelance writing situation, predicting: "'AI' will not replace you. A person making half what you do with no benefits whose job is the same as yours was but now includes babysitting 'AI' will." That is the real automation charade, and it's less about AI than we think.

Technology critics are sometimes called Luddites, after the band of English factory workers that destroyed knitting machinery in the 19th Century. But a closer look reveals that the Luddites weren't anti-machine at all. They were protesting the manufacturers, who were using the new technology as an excuse to ignore standard labour practices.

The important thing to understand is that the current deskilling and devaluing of labour isn't because the robots are coming for us – it's cultural. A lot of our society's willingness to view human workers as a replaceable commodity stems from the Fordist production model and ideology of the 20th Century. But even though we've embedded that mentality in our systems, it's not the only way to treat human labour.

As jobs get disrupted and people's livelihoods are threatened, it's easy to point fingers at technology as the inevitable reason, whether you're a pundit or an employer. But the real culprit is a political and economic system that puts profit above all else, and a society that is willing to let workers be mistreated. It's a big thing to change, but it's not set in stone. And that's the real 'robots and jobs' conversation we need to be having.

COMMENT

HOW ONE PARTICLE COULD SOON REWRITE OUR LAWS OF THE UNIVERSE

The particle that gives all matter mass may have played a key role in the birth of the Universe

When we look across vast distances using our most advanced telescopes, we look back in time. Einstein taught us that light has a finite speed; therefore, it takes light longer to travel to us the further one looks.

Thanks to this, cosmologists have been able to see light dating back to about 14 billion years ago. This light reveals something spectacular and mysterious – the Universe was once filled with a sea of energy, waves of tangled electrons and photons in the form of a hot fluid, known as a plasma. We call this plasma the cosmic microwave background (CMB).

We cosmologists have precise theoretical and observational evidence that this plasma underwent gravitational collapse with the aid of an invisible form of matter, called dark matter, forming the first stars and, eventually, the organised superstructure that inhabits the current Universe. However, a mystery still lurked: the properties of this sea of energy seem to originate from what Einstein called "spooky action at a distance" – objects communicating with each other at instantaneous speeds across ridiculously large distances. This is known as the horizon problem.

In 1981, Alan Guth of MIT proposed an elegant solution to this problem. He introduced a new player called the inflation field that filled the Universe, and whose energy caused space to expand extremely rapidly. The repulsion that arises due to gravitational effects caused by inflation neatly solves the horizon problem – it makes those regions that we thought to be 'spookily interacting' subject to the weird, but well-confirmed, laws of quantum physics.

The theory of cosmic inflation also provided us with a physical mechanism that answers a question that had long troubled cosmologists: how did the seeds of structure originate in a featureless primordial Universe over 14 billion years ago? As per the theory, it was the very tiny quantum vibrations of the inflation field that acted as the seeds of the vibrations we see in the CMB today. This means that the vast distribution of galaxies spanning trillions of kilometres of space, emerged from microscopic subatomic quantum fluctuations that occurred at the earliest stages of the Universe.

I was first attracted to the field of particle physics and cosmology by what appeared to be a preposterous question: what is the connection between the largest and smallest things in the Universe? Cosmic inflation gives us a clue to this but two unresolved, apparently unrelated, mysteries remain.

ILLUSTRATION: MATT HOLLAND

"The Higgs is a field and particle, which, like a fluid, can permeate all of space"

First, we don't know the origin and identity of this inflation field. All we know is that it behaves like a particular type of field, known as a scalar field, and that it permeates the largest distances imaginable.

The other serious problem for inflation is that the very quantum fluctuations that gave birth to us, can grow without being bound by infinity. And that poses a problem: some theorists would like to get rid of the infinity bathwater and keep the baby of cosmic structure. These contradictions, called 'instabilities', have proven difficult to reconcile.

A further mystery reigns in the microscopic domain and concerns the origin of mass. In the 1960s, Peter Higgs, Tom Kibble, François Englert, Robert Brout, Carl Richard Hagen and my professor Gerry Guralnik predicted that a mysterious particle, now dubbed the Higgs boson, and its corresponding field of energy that pervades the Universe, could interact with massless matter and give it its weight. This particle was later detected by the Large Hadron Collider at CERN in 2012, and a Nobel Prize awarded to Higgs and Englert a year later.

But despite these successes, there is a problem with the Higgs: it shares a similar instability with inflation, this time in the very quantum fluctuations of the Higgs that give us our mass.

In recent years, physicist Mikhail Shaposhnikov has postulated that perhaps the microscopic Higgs boson could be behind the omniscient, primordial inflation. But how does one reconcile this picture of micro and macro? The key is to realise that the Higgs is fundamentally a field and particle, which, like a fluid, can permeate all of space. It's the wave-like vibrations of the Higgs fields organising themselves into microscopic, localised quantum fluctuations that are identified as the Higgs particle. So, could the Higgs field have permeated the early Universe and given rise to the phenomenon of cosmic inflation? If this idea of Higgs Inflation is correct, it would represent a cosmic-microscopic unification.

There is a serious elephant in the room that continues to plague both ideas, however. They rely on quantum fluctuations to create cosmic structure and endow mass, respectively. The problem is that these quantum effects end up generating infinities in quantities that we measure to be finite.

For now, the solution remains elusive. We physicists must courageously, and humbly, continue down the rabbit hole of conundrums that lurk in any theory.

STEPHON ALEXANDER
(@stephstem)
Stephon is a professor of physics at Brown University, an author and an accomplished jazz saxophonist.

REALITY CHECK

SCIENCE BEHIND THE HEADLINES

Tick bites | Alien life | Gene-edited food

REVIEW

TICK BITES: HOW TO AVOID THEM AND WHAT TO DO IF YOU GET BITTEN

With the number of critters on the rise, the UK is seeing increasing cases of tick-borne viruses

"When ticks bite they can transmit microorganisms into our blood through their saliva."

Visit the BBC's Reality Check *website at* ***bit.ly/reality_check_*** *or follow them on Twitter* ***@BBCRealityCheck***

Earlier this year, a 50-year-old man in Yorkshire became the first person in England to contract a confirmed case of tick-borne encephalitis, after being bitten while mountain biking. The virus has since been detected in Dorset, Norfolk and Hampshire. With tick numbers increasing in the UK over recent years, the likelihood of being bitten is also rising. So just how dangerous are tick bites?

WHAT ARE TICKS?

Ticks are arachnids, like spiders and scorpions. Many of them look superficially like very small spiders. They belong to a group of arachnids called the acari, which also includes the mites. Most mites are tiny – 1mm or less – and are often overlooked. Better-known species include the scabies mite, which causes a skin condition in humans, and the varroa mite, which infests honeybees. Despite these well-known parasitic species, many mites are decomposers or predators. However, their close cousins – ticks – are all parasites that feed on animal blood.

There are nearly 1,000 species of ticks found across the world, mostly in warm, humid regions. There are two main types: hard-bodied ticks, of which there are more than 700 species, and soft-bodied ticks. It's the hard-bodied ticks that cause the most problems for us. Their mouthparts form a beak-like structure that can pierce our skin, allowing them to feed on our blood.

WHAT DISEASES DO THEY CARRY?

When ticks bite they can transmit microorganisms into our blood through their saliva. These include bacteria, viruses and single-celled organisms. In some cases these 'passengers' can cause disease. And not just in humans: wild animals and livestock can also be affected by tick-borne diseases.

Nearly 30 such diseases have been identified in humans, including Rocky Mountain spotted fever, babesiosis, Lyme disease (also known as borreliosis) and tick-borne encephalitis. Many tick-borne diseases cause fevers and, in some cases, there are relapses and long-term health issues. The increasing prevalence of ticks and the diseases they transmit can be attributed, in part, to an increase in their population size caused by climate change.

WHAT ARE THE MOST COMMON WAYS TO GET BITTEN?

Ticks live outside and most people who spend a significant amount of time outdoors will likely have experienced a tick bite. They're most common in grassland but can also be found in woodland, especially where there is long grass on the edge on wooded areas.

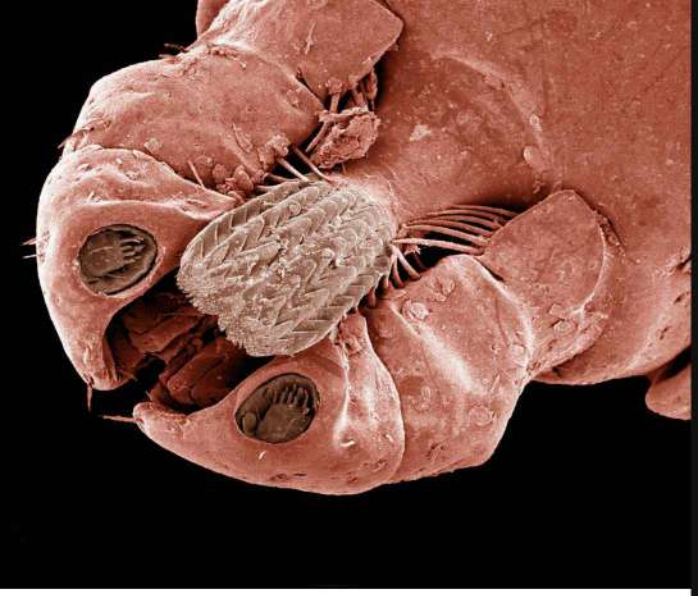
Ticks 'quest', waiting on long grass for large animals, including us, to brush by. They then grab on and seek out bare skin. Larval ticks, sometimes known as pepper ticks, are very small and will often form large groups of hundreds or more, a 'tick ball', on blades of grass. If you walk through grasslands in hot places, such as on the African savannah, then tick balls are a common hazard.

WHAT SHOULD I DO TO AVOID GETTING BITTEN?

Firstly, cover up. A long-sleeved top tucked into trousers, ideally tucked into socks, will cover up →

BELOW Lyme disease is spread by ticks and can causes rashes, headaches, fever, fatigue and joint pain

ALAMY, SCIENCE PHOTO LIBRARY



ABOVE Hard-bodied ticks have beak-like mouths

→ vulnerable skin and limit the opportunities for ticks to attach. Lighter colours also allows you to see ticks crawling over your clothes as they seek out bare skin.

If you can, avoid areas of long grass and stick to the middle of footpaths. Applying chemical repellent such as DEET, being careful to follow the instructions, can also help. When you can, perform 'tick checks' on yourself and, if in a group, each other. Ticks walking across clothes can be brushed off easily, but take care not to brush them onto someone else.

HOW SHOULD I REMOVE A TICK THAT HAS BITTEN ME?

Many techniques have been recommended, but the key thing is not to leave the mouthparts of the tick behind. The best method is to use tweezers to grasp the tick as close to the skin as possible, pushing the skin gently down around the head to get hold of it. Then, slowly and gently but firmly, pull the tick from the skin. Wash the area thoroughly with soap and water afterwards, and then apply an antiseptic cream to the bite. The NHS website offers good advice for tick removal.

WHAT SHOULD I DO IF I GET BITTEN?

Being bitten does not mean you'll develop a tick-borne disease: complications from tick bites are relatively rare. But there is no way to tell straight away if a tick bite will develop into anything more serious, so there are some things you should watch out for.

In the UK, Lyme disease is the main concern and can develop three to 30 days after being bitten. You should monitor the bite and your general health and if you develop a rash, often resembling the bullseye of a dartboard, or flu-like symptoms, then you should consult your GP, telling them you have recently been bitten by a tick.

Do remember, however, that although the 'bullseye' rash is well-known as a symptom, only around a third of people with Lyme disease will develop it.

by **PROF ADAM HART**
Adam Hart is an entomologist and Professor of Science Communication at the University of Gloucestershire

ANALYSIS

ALIENS: THE TRUTH IS OUT THERE, SAYS HARVARD PROF

Prof Avi Loeb says we shouldn't dismiss the possibility that extraterrestrials are already observing us

Everyone, it seems, has heard of the idea that the US government is sitting on proof that extraterrestrials exist and have been visiting Earth for decades. It's a conspiracy theory so prevalent it has entered the mainstream.

It's easy to dismiss such stories but, seriously, could there be even a small amount of truth in it? Could extraterrestrial probes really be functioning near Earth? We don't know. But Harvard astronomer Prof Avi Loeb's Galileo Project aims to investigate.

What used to be called UFOs (unidentified flying objects) have now been retitled as UAPs (unidentified aerial phenomena). In a blow against the conspiracy theorists, a report from the US Office of the Director of National Intelligence was released in 2021 detailing the UAPs they had been investigating.

According to the document, 144 UAP reports were made between 2004 and 2021, mostly by military personnel. Few conclusions could be drawn, however, because the actual data was limited and difficult to analyse – and that's where Loeb plans to help out.

"I think the government is puzzled. They don't know what to make of it. They're not scientists," says Loeb. "I say let's just figure it out, let's not have any prejudice, just collect better data. That's the scientific method. That's the way science is done."

The goal of the Galileo Project, therefore, is – according to the project's website (bit.ly/GalileoProject) – to transform the search for extraterrestrial technological signatures from accidental or anecdotal observations "to the mainstream of transparent, validated and systematic scientific research".

To collect such data, the project team has assembled a special observatory at Harvard University in Cambridge, Massachusetts. It monitors the entire sky, tracking everything that passes overhead. The trick, according to Loeb, was adapting the equipment to track fast-moving objects, because when looking out into the distant Universe, astronomical telescopes are never required to move quickly.

Loeb became interested in using science to investigate the idea of extraterrestrial visitation back in 2017, when astronomers discovered the unusual asteroid 'Oumuamua. Only spotted as it was leaving the Solar System, 'Oumuamua was unusual

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“I think the government is puzzled. They don’t know what to make of it. They’re not scientists. I say let’s just figure it out.”

in that it appeared to be roughly cylindrical rather than potato-shaped, as is usual for asteroids. It also appeared to accelerate in a way that could not be explained by the gravity of the Solar System.

Most astronomers assumed that it must have released some gas, like a comet, causing it to accelerate. But Loeb found himself thinking that this would be exactly the type of behaviour that you would expect from an alien spacecraft.

He noticed another coincidence, too. Six months before ‘Oumuamua’s closest approach to Earth, a metre-sized meteor hit our planet. Its speed and trajectory indicated that it had come from outside the solar system. Although its orbit was not correlated with that of ‘Oumuamua, it inspired him to consider the possibility of an interstellar craft releasing small probes to investigate the planets it was passing. He called these hypothetical probes ‘dandelion seeds’ and wondered whether any of the reported UAPs outlined in the 2021 release might fit the bill.

ABOVE Harvard’s Prof Avi Loeb is working to expand the parameters of our search for intelligent alien life

In 21 of the 144 reports, some sort of unusual movement was reported. Often this movement is extremely fast, but as Loeb and Dr Sean M Kirkpatrick, who heads the Pentagon’s All-domain Anomaly Resolution Office, point out in their draft paper, extremely fast movement through the air results in an optical fireball – just like when meteors burn up in our atmosphere.

They suggest that the lack of a fireball could mean that the objects are closer to the observer than assumed, and therefore smaller and moving more slowly. →

ABOVE 'Oumuamua was not your average asteroid

→ But in order to know for sure better data is required, underlining the need for rigorous measurements.

Prof Michael Garrett, a radio astronomer at Jodrell Bank, University of Manchester, is vice-chair of the International Academy of Astronautics' SETI Permanent Committee. He sees Project Galileo as a bridge between two subjects that have traditionally been widely separated: UFOlogy and the Search for Extraterrestrial Intelligence.

Whereas both disciplines have been viewed with extreme scepticism or even ridicule by the scientific community, the latter has now managed to establish itself as a valid scientific avenue of enquiry. In SETI, radio astronomers use their telescopes to listen for any extraterrestrial signals passing by Earth.

"If I accept that there's intelligence out there and that might have been around for a long time, I also have to accept that there might be phenomena, including phenomena that could visit us, that's associated with intelligence. I can't somehow think there might be intelligence somewhere on the other side of the Galaxy and then say, 'Oh, yeah but it can't be here'. Those two things, to me, don't make sense and are not logical," says Garrett.

The first data from Loeb's prototype observatory is expected this summer. However, the project is currently based at just one site – to make real progress he needs more. His team is now constructing others to be deployed elsewhere in America. If they can attract the necessary funding, which would run into tens of millions of dollars, they plan to extend these observatories all around the world. Loeb is then hopeful that they'll collect the data required.

"It's basically like multiplying the number of objects that we monitor. To get to the bottom of this we have to have enough locations to get good statistics, and clarify whether there is anything other than natural or human-made objects," says Loeb.

by **DR STUART CLARK** *(@DrStuClark)*
Dr Stuart Clark is an astronomy journalist, author and lecturer, and a Fellow of the Royal Astronomical Society. His latest book is Beneath The Night *(Faber, 2020)*

COMMENT

GENE-EDITED FOOD: WHERE'S MY SUPER MEAL?

Can gene editing create 'superfoods' that actually live up to the hype? Well, maybe...

So-called 'superfoods' are often touted as being beneficial for our health but the concept is mostly just marketing hype designed to sell us more expensive fruit and veg, rather than providing any actual benefits. However, with gene editing now approved by the government for use in commercial crops in England, that could be about to change.

Gene editing, using technologies like CRISPR/Cas9 or TALEN, is faster and cheaper than conventional breeding techniques and less controversial than genetically modified (GMO) foods. This is because, instead of inserting whole genes from outside of the plant, as is the case with GMOs, gene editing allows for small and targeted changes to subtly alter the genetic makeup of existing crops, potentially allowing us to create foods with different properties.

We all know that fruits, vegetables and whole grains are good for us, but most people don't eat the amount or variety recommended for good health. One of the ideas behind gene-edited crops is that nutrient levels could be boosted in certain fruits and vegetables, making it easier for us to eat a healthy, balanced diet.

In fact, lots of crops based on this idea have already been produced. One example is soybean and rapeseed that has been edited with one gene suppressed to produce a healthier fat profile. Similarly, bananas and rice have been made to include extra vitamin A, and other crops have been enriched with vitamin E, iron and zinc. These nutrients have been targeted because they're key deficiencies in many people's diets. But clever editing could mean we need fewer servings of fruits and vegetables, so we wouldn't have to stress as much about reaching our intake or variety targets. Imagine an apple that could provide all your daily vitamin and mineral needs, so that an apple a day really could keep the doctor away.

What's more, gene-edited food sources could be superior to current nutrition-boosting methods such as supplements, meal replacements and fortified foods. Supplements contain high doses of vitamins but don't contribute to fullness or come with the social aspects of eating. These features are also lost in complete nutrition solutions and diet shakes. Similarly, fortification can add extra nutrients into

NASA, ALAMY

"The potential improvements for nutrition and health that gene editing offers are almost endless"

ABOVE Allowing gene-edited crops opens the door to 'food as medicine' but a degree of caution is needed

staples like bread and margarine but these foods aren't necessarily the healthiest choices to start with.

The concept of food as medicine has existed since ancient times and stems from studying not only the nutritional properties of foods but also their bioactive contents. Bioactives – natural compounds that aren't technically essential but can enhance health – are found in high amounts in plant foods. Examples include polyphenols, short-chain fatty acids and sterols, which can have benefits in aiding inflammation, obesity, cardiovascular health, cognition and more.

Gene-editing could open doors to designing foods that function as medicines, not just for better physical health but for mental health too, without the downsides of adding single functional components to foods that might not otherwise be healthy. We could also edit out features of foods that might be causing harm.

Currently, tomatoes are one of the leading examples of gene-edited food. Researchers in Japan have used gene editing to enhance levels of GABA (gamma-aminobutyric acid), which may contribute to improved heart and mental health. Gene editing has also reduced tomatoes' naturally high levels of oxalic acid, which can trigger flares in people with gout.

So the commercial availability of gene-editing could lead to 'prescription foods', combining food as medicine with personalised nutrition. Foods that cause allergies or intolerances could also be edited so that they can be put back on the menu.

Unfortunately, the foods that are the best for us are often the ones that we find the least palatable, so making healthy foods tastier could help us to eat more of them. Gene editing can be used to enhance sweetness, reduce bitterness, and dial up flavour and aroma. This could encourage people to eat more healthy plant-crop foods. There are already companies such as Pairwise, who are creating greens with less bitterness and fruits that pack even more flavour.

We can't just create new nutrient-dense varieties and assume that will translate into greater benefits, however. Nutrients, bioactives and other components in food all interact with each other: some combinations boost the absorption and action of others but in other cases, interactions lead to reduced uptake or function. We need to ensure we don't edit out healthful compounds, as negative attributes like bitterness often come from beneficial compounds, or edit in extra calories. Likewise, adding nutrients and bioactives could have adverse impacts on taste, so a balance will need to be found.

The potential improvements for nutrition and health that gene editing offers are almost endless. But because food is so complex, we need to continue to do the research alongside each stage of development to ensure we don't make any false assumptions. **SF**

by **DR EMMA BECKETT**

Dr Emma Beckett is a senior lecturer in food science at the University of Newcastle, Australia. Her work has appeared in journals such as Nutrients *and the* American Journal of Human Biology.

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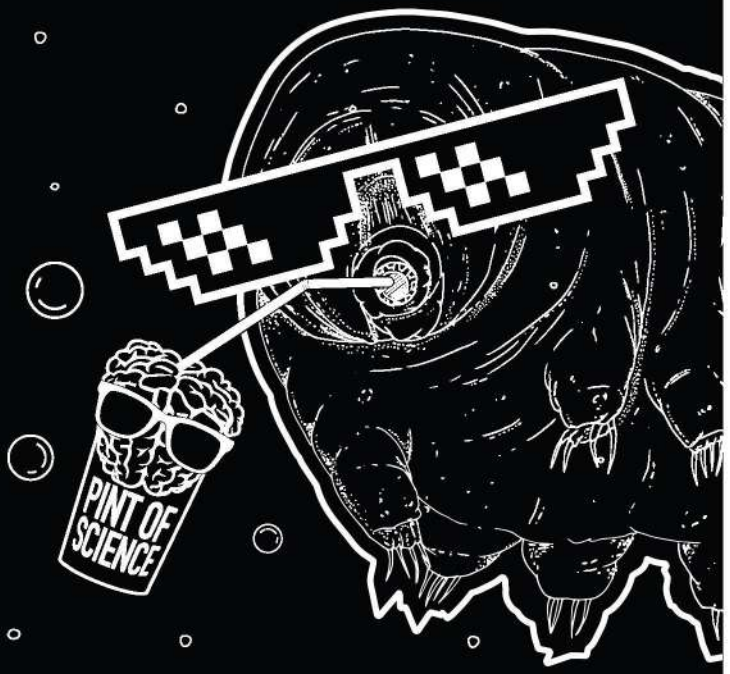

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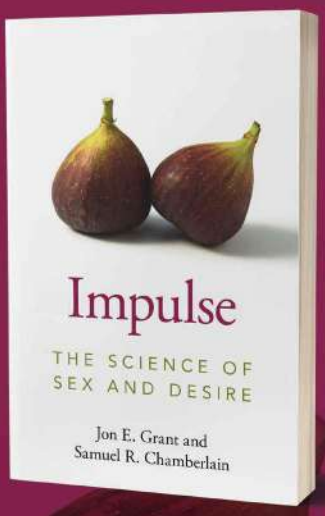

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INNOVATIONS

PREPARE YOURSELF FOR TOMORROW

REVIEW

SAMSUNG GALAXY S23 ULTRA

Yes, it's great... but how much do they want for it? **p42**

INTERVIEW

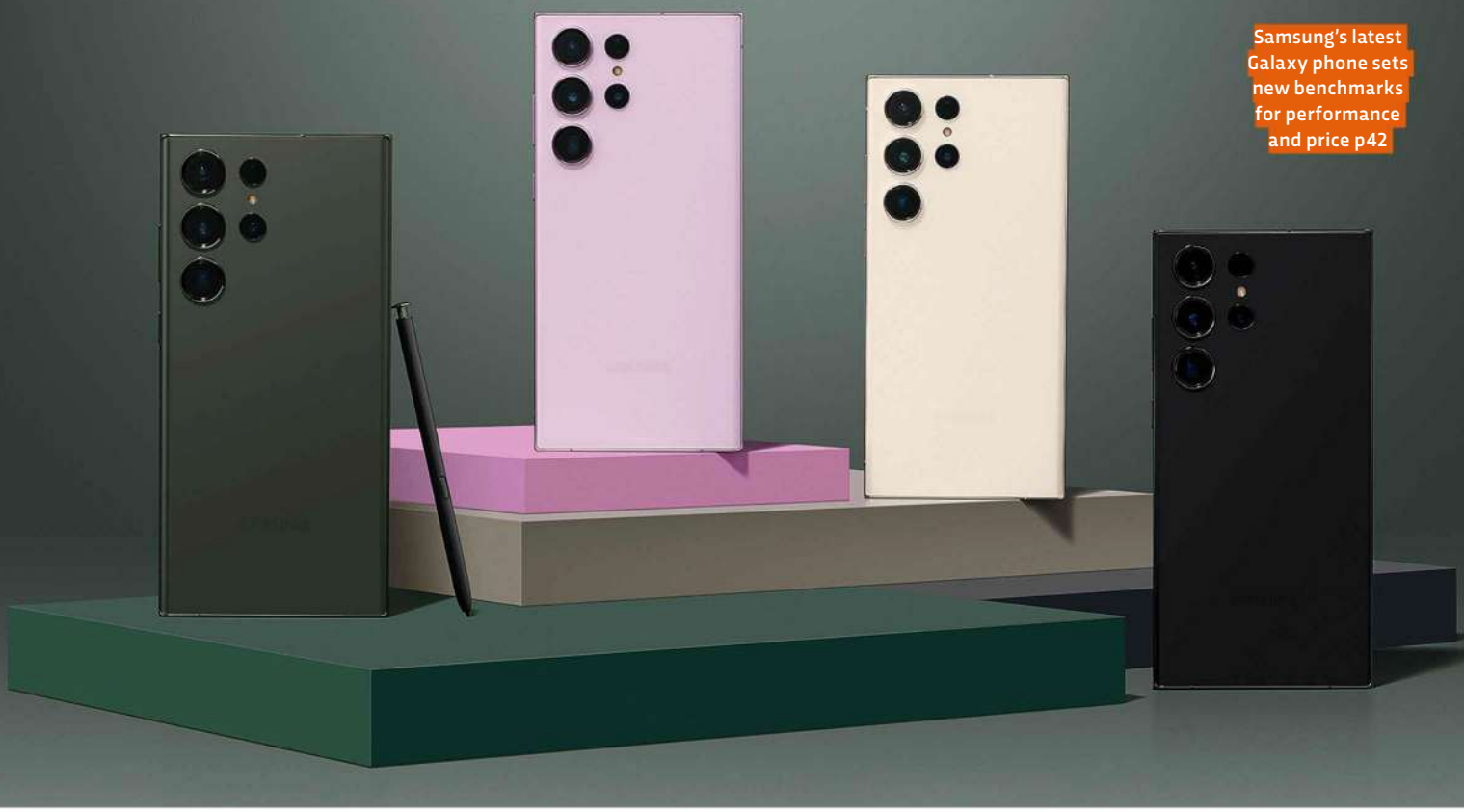
MIND CONTROL?

Wearable 'brain sensing' tech is all the rage. Should we be worried? **p44**

NEW TECH

IDEAS WE LIKE

Our pick of this month's greatest new gadgets **p46**



Samsung's latest Galaxy phone sets new benchmarks for performance and price p42

86.2% of the world's population currently owns a smartphone

Around half of all smartphone users in the UK have an iPhone

$13.5 bn

The expected value of the smartphone market in 2023

REVIEW

Samsung Galaxy S23 Ultra: overkill never looked so good

Want the best Android smartphone? It's right here, says Alex Hughes but it'll cost you

Once again, Samsung has made one of the best smartphones you can buy. The S23 Ultra is powerful, sleek, built-to-survive and generally everything you could ever want from a phone. And yet, it's going to be a device that very few people should buy, because the S23 Ultra is excessively expensive, kindly asking you to fork out a minimum (yes, minimum) of £1,249.

It's the sort of price that begs two big questions. One: can a smartphone really be worth this much money? And, two: if you are willing to spend your life savings on one, is the S23 Ultra right for you? I spent some time with it to find out.

The lenses, screen, stylus and processor combine to make the S23 a great camera phone

WHAT'S IT LIKE TO USE?

This is not a smartphone for small-handed people. It's tall, chunky and heavy, but it makes up for all of that by looking like… well, a smartphone that you spent over £1,000 on.

Made of premium aluminium, with a curved Gorilla Glass display and a smooth-to-the-touch feel all over, it's almost a crime (albeit a very sensible one) to put a case on this handset.

Another very good reason to invest in a case is to level it out, as the camera lenses on the back do a convincing impression of the Himalayas. Lay the bare phone down flat, and the lens corner is awkwardly propped up at a surprisingly high angle.

The display is, as you would imagine, superb. It spans a huge 6.8in (17cm) and offers plenty of brightness even for the sunniest of days. It looks crisp and for shows that are all about image quality, this is about as close as you're going to get to true reflection in a smartphone.

During my time with the S23, it was refreshing to see just how long the battery could last. It has the same capacity as its predecessor (the S22) but thanks to a more advanced chipset, is better at controlling power use. I was often able to get a full day of heavy usage out of it. That new advanced chipset is the Snapdragon 8 Gen 2. Samsung claims that it's one of the most powerful processors to ever make its way into a smartphone, and in my tests, the claim stands up.

"LAY THE BARE PHONE DOWN FLAT AND THE LENS CORNER IS AWKWARDLY PROPPED UP AT A SURPRISINGLY HIGH ANGLE"

Killing time on my morning commute, I played some *Diablo Immortal*, *Asphalt 9* and *Apex Legends Mobile*, and they all performed with ease. Equally, I put the S23 through some benchmark tests that all showed impressive numbers, which only Apple's iPhone 14 Pro Max could match.

But, while lots of processing power is great, unless you're pushing your phone to the max, it doesn't really matter. Hints of this new chipset's chops can best be

Samsung has packed tech into the Galaxy S23 Ultra to ensure superb selfies every time

GETTY IMAGES

seen in battery management and image processing (more on that below).

Like previous editions, a stylus is tucked neatly inside the bottom of the phone and, for some, this will be an essential feature for drawing, writing and major boosts in productivity. I've never been that convinced by styluses, but this one is useful for signing digital documents, as well as taking and editing photos while the device is propped up.

MORE CAMERA THAN PHONE

Turn the smartphone over and you'll be greeted by four huge lenses and some sensors, so it's no surprise that there's a lot of camera tech crammed inside.

This is the first phone to make use of a 200MP camera lens, which Samsung claims is powerful enough to produce poster-size prints. To use the 200MP lens, Samsung relies on technology that combines 16 pixels into one larger pixel. It sounds like a weird process but it results in much brighter and more detailed images. I was taking photos with lots of subjects and background clutter, and was still able to zoom in on faraway objects with plenty of clarity.

Like previous models, the zoom function can reach an impressive but rather shaky 100x magnification. While I rarely used this mode, the levels of zoom available all the way up to it work great, far exceeding rivals like the Google Pixel 7 Pro.

The selfie camera has been improved too. Shots are clearer, brighter and better able to pick up on small details. Unlike previous Samsung cameras that have the tendency to over-edit, the front camera offers a very realistic shot.

Very few phone cameras have ever been as good as this. Not just because it can produce fantastic images but because of how versatile it is. Need a clear shot of the Moon? Easy. Want a good selfie? No problem. Close-up shot of people eating food at night? Piece of cake.

VERDICT

I looked for issues, glitches and general annoyances, but could find only one: the price. This is a near-faultless smartphone, but should you really be surprised when it costs £1,249 at its cheapest?

Just like the iPhone 14 Pro Max, the Samsung Galaxy S23 Ultra offers everything you could ever want in a smartphone. A great display, a stunning design and build, more than enough power, an unrivalled camera and plenty more.

The issue is, a lot of what makes it so good, you don't need. A super-powered chipset is great, but is rarely necessary. A 100x zoom is amazing, but is rarely needed and for most people, a stylus built into a smartphone isn't going to be all that helpful.

The Ultra is about excess and being the best product possible, and I love that. But the one question I'm left asking is: how much am I willing to pay for the best Android smartphone around?

RATING

★★★★★

PROS:

- Fantastic camera
- Premium and stylish build
- Powerful internals
- Brilliant display
- Top-notch battery

CONS:

- Ultra expensive
- Large size won't be for everyone

THE BEST ALTERNATIVES

IPHONE 14 PRO MAX

There are plenty of smartphones that try to match the S23 Ultra but Apple's iPhone 14 Pro Max is its only true rival. Just as expensive, it adopts the same idea of excess, packing in the features to guarantee you won't think your money's been wasted. Stunning screen, great camera and a processor that can handle it all, it's Apple's best device to date.
Apple.co.uk, £1,199

GOOGLE PIXEL 7 PRO

If you like the idea of having one of the latest and greatest smartphones, but the iPhone 14 and S23 Ultra leave you winching at their prices, the Google Pixel 7 Pro is the perfect alternative. It's a little more affordable, but still offers some of the best features and specs around. With a solid level of power and an iPhone- and Samsung-rivalling camera, the Pixel 7 Pro isn't quite a direct competitor, but it isn't far off.
Store.Google.com, £849

SAMSUNG GALAXY S23+

Let's be honest, the Samsung Galaxy S23 Ultra is great... but costs too much. Luckily, if you like everything but the price, you can opt for the slightly cheaper Plus model. It keeps a lot of what makes the Ultra great, but makes a few key reductions to lower the price.
Samsung.com, £1,049

INTERVIEW

For the wearable tech of tomorrow, we need to rethink our human rights

Alex Hughes speaks to neurotechnology ethics expert **Nita Farahany** about the future of wearables

Through technology, we're now able to track our steps, our heart rate and even our vascular age. But as technology advances, there is a new metric to access – our brain waves. New 'brain sensors' promise much, but as Nita Farahany – an author and professor specialising in the ethics of emerging technologies – explains, we may need to readdress our basic human rights to prepare for them.

ARE THERE REALLY NOW DEVICES THAT CAN ACCESS OUR BRAIN WAVES?

Yes, but it's a question of both scale and precision. There are millions of consumer brain wearables sold worldwide. These are in the form of headbands or sensors that can be embedded into a hard hat or a baseball cap to track brain activity. The algorithm's interpreting that activity, but right now they're somewhat limited in what they can do. They can decode someone's attention, engagement, if their mind is wandering, and basic emotions like stress, happiness or sadness.

Major tech companies are investing in integrating brain sensors in the same way we see heart rate monitors in watches and rings, integrating brain sensors into everyday devices like earbuds, headphones or even wearable tattoos. Some companies have announced that they plan to launch a neural interface as a way to interact with the rest of our technology in augmented and virtual reality by 2025.

Nita Farahany is a professor at Duke University's School of Law

WHAT IS IT THAT THESE BRAIN SCANS ARE ACTUALLY MEASURING?

These are not mind-reading devices, they can't understand our detailed thoughts. One common technology used is electroencephalography (EEG), which picks up electrical activity in your brain as you're thinking or experiencing anything. Neurones are firing in your brain in a way that sends characteristic patterns, giving off tiny electrical discharges that can be picked up by the EEG. Through powerful algorithms, these patterns are decoded. From this, we can measure attention, mind-wandering, and basic feelings and emotions.

Pair that with a screen someone is looking at, and we can track environmental data, too. Flash up political candidates from different parties on my screen while I have brain sensors attached and you could classify my responses to any particular party. Researchers have also tried subliminally embedding, in a gaming environment, PIN numbers or addresses to see if recognition of that information could also be reliably detected from brainwave data.

IF WE'RE ABLE TO 'CRACK OPEN' THE BRAIN, HOW WILL THIS AFFECT THE MENTAL HEALTH AND WELLBEING SPACE?

There are devices approved for the treatment of depression through neurofeedback, but also through electrical stimulation of the brain. People could use the data to detect earlier stages of mental health disorders or neurological disorders in much the same way that people track their heart rate, breathing and the number of steps they've taken.

Tracking mental health data will likely be normalised with this objective data from the brain. Do you work best at home or in an office, based on focus and attention levels? Did that glass of wine affect your sleep? It can all be tracked with your mental health. A lot of companies are investing to crack open the brain and quantify what they find.

COULD THIS TRIGGER A BRAIN HYPOCHONDRIAC MOVEMENT?

It's definitely possible. We know very little about our brains, but what we do know is that there is diversity between brains and brain activity for different people. In the early days of this, the algorithms may misidentify people as having something neuro-atypical happening in their brains. People will also be studying their own data to see if there is anything they should be worried about. As people begin looking at their brain data, they may start to become worried about what they see there and potentially needlessly worried in ways that could be problematic.

OFTEN, TECHNOLOGY IS CREATED AND THEN THE QUESTION OF ETHICS IS ADDRESSED AT A LATER STAGE. WHAT CAN WE DO BEFOREHAND TO GET AHEAD?

I advocate for recognising a right to cognitive liberty now as an international human right. That means updating our existing rights and our interpretations of them.

Many major tech companies have launched 'brain sensing' devices

"THE HUMAN RIGHT TO PRIVACY SHOULD INCLUDE MENTAL PRIVACY. THE RIGHT TO FREEDOM OF THOUGHT SHOULD BE INTERPRETED BEYOND IDEAS OF RELIGION AND BELIEF"

NEUROSITY

That's a good first step: setting both a global legal framework and a norm that recognises that self-determination of our brains and mental experiences as fundamental. It also prioritises personal data, giving consumers the right to control their personal information, over a company's right to use it. Not a default rule where corporations can collect, commodify, mine and analyse that data for any purpose they wish. The starting place is to flip what has been a system that really favours corporations over individuals, giving people the right to the data from their brains.

WHAT IS COGNITIVE LIBERTY AND WHY IS IT SO IMPORTANT?

One of the biggest problems with the technology we're talking about is the risk to our brains. The sense in which our brains are accessed, tracked and hacked by technologies in ways that are contrary to human flourishing. Cognitive liberty is a right to self-determination over our brains, updating the concept of liberty for the digital age.

The human right to privacy should include mental privacy. The right to freedom of thought should be interpreted beyond ideas of religion and belief, to protect our robust thoughts and images in our mind from being accessed. And the right to self-determination should give us a right to access and to change our brains if we should choose to do so.

IS THIS DEFINITELY A TECHNOLOGY OF THE FUTURE OR COULD THIS BE A GOOGLE GLASS OR METAVERSE SITUATION?

I'd be surprised if it doesn't work out. After all, it doesn't make sense for us to know so little about our own brains. Neurological disease and suffering are rising and their toll on an individual is extraordinary. Our physical health and longevity are improving, but our mental health and wellness is declining. If this kind of technology gives us the tools to be empowered to take charge of our own brain health, then it could truly be revolutionary. It's not a novelty we don't need, it's fundamental.

Ideas we like...

Our pick of the month's smartest tech

↓

...Shower speakers on a budget

Too often, we focus on technology that dazzles, performing impressive feats at shockingly high prices, rather than spending time on the no-frills devices that just work. IKEA's new shower speaker costs a comforting £12 and yet boasts a more-than-impressive 80-hour battery life. It's not going blow you away with audio, or bounce 360° sound around the room. Instead, this is made for the person on a budget, looking for an easy shower speaker that they don't have to think about.

IKEA Vappeby
Ikea.com, £12

...The ultimate power bank

Nitecore is a brand set on making power banks that ooze excess. You don't *need* to charge 124 iPhones, monitor your power bank's output via an app, or charge 10 devices at once, but if you're going to invest in a power unit, why not have it all? The Nitecore NES2000 has solar panels, a fire-proof design, wheels, and can charge a car battery. It's far more than the average camper needs, but it has shot straight to the top of our wish list.

Nitecore NES2000
£TBC, Nitecore.com

...Spatial audio on a budget

Spatial audio is the latest development hitting the home audio scene. It takes small home speakers, and through what we imagine is a combination of magic and clever technology, creates the feeling that the audio is surrounding you. Clever right? Yes, but also expensive. Luckily, for those on a tighter budget, Anker has crammed the technology into a stylish and well-built £200 speaker that can support high-fidelity music files.

Anker Soundcore Motion X600
UK.soundcore.com, £199.99

...The saviour of sausage rolls

Makita has a solution to a problem philosophers have been pondering for centuries: how do you heat up your Greggs sausage roll when you don't have an oven? The answer, for builders and campers alike, is Makita's battery-powered microwave. No price info has been released yet, we wouldn't hold out hope for a cheap addition to your building-/camp-site setup.

Makita Cordless Microwave
Makitauk.com, £TBC

...A gadget for dedicated athletes

Nix Biosensors is attempting to fine tune your exercise routine by focusing on your sweat. For the nerdiest… sorry, most dedicated athletes who like to sweat every detail, Nix has created sensors that track your hydration levels and send texts to tell you when, and how much, to drink. They also track your electrolyte loss, sweat composition and other weirdly detailed, yet interesting statistics.

Nix Biosensors
Nixbiosensors.com, £106

IDEAS WE DON'T LIKE...

...CLOTHES INSPIRED BY THE METAVERSE

The metaverse has inspired a whole range of strange trends, concepts and... well, let's be honest, scams. But one thing we weren't prepared for was real-life pixelated clothes. For a somewhat crazy price of £7,300, you can set yourself up with an outfit consisting of a hoodie, trousers, t-shirt and a handbag. An expensive optical illusion, created with large blocky patterns, these clothes offer a *Minecraft*-style pixelation that is certainly... unique. Would it turn heads in the streets? Absolutely! Is it something we'll be adding to our wardrobe anytime soon? It's unlikely.

Loewe Pixel outfit
Loewe.com, £7,300

...A SMART HOME FOR CHICKENS

Among the many tech trends we were expecting for 2023, smart homes for chickens was, unsurprisingly, not even close to making the list. And yet, it's here. COOP, the company behind it, has included all the obvious features you'd see in your average chicken coop: a cooling system, full video security setup and a remote-accessed door. It's certainly unique but we're not sure how many people will be paying the whopping $2,495 (£2,000) for their chickens to enjoy air-conditioning and a remote-controlled entrance. There is, however (and yes, we're aware is the perfect spot for a joke), an early-bird discount available.

The COOP
Coop.farm, $2,495

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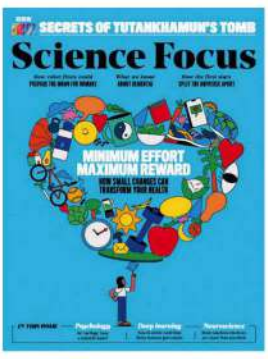

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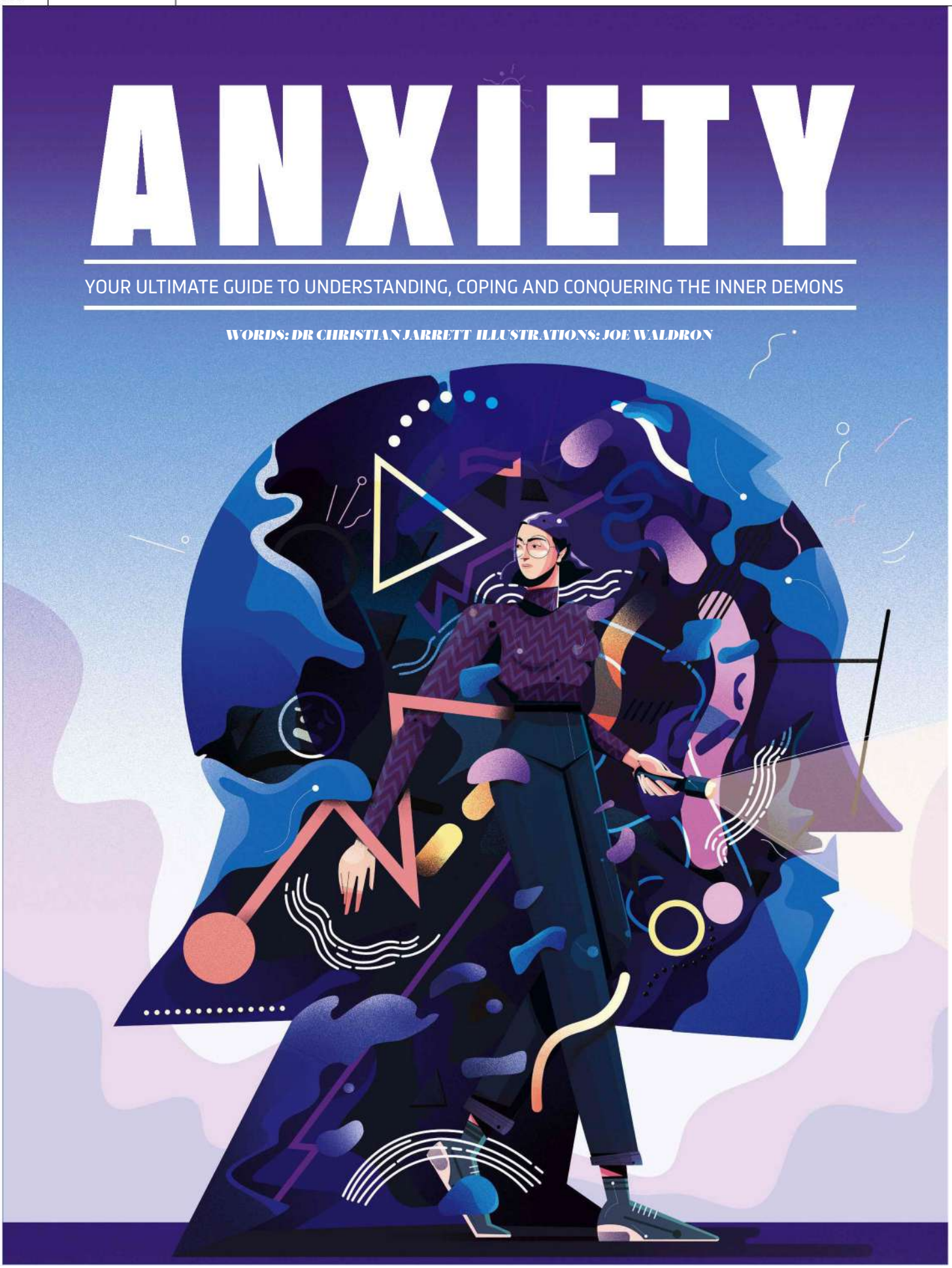
ANXIETY

YOUR ULTIMATE GUIDE TO UNDERSTANDING, COPING AND CONQUERING THE INNER DEMONS

WORDS: DR CHRISTIAN JARRETT ILLUSTRATIONS: JOE WALDRON



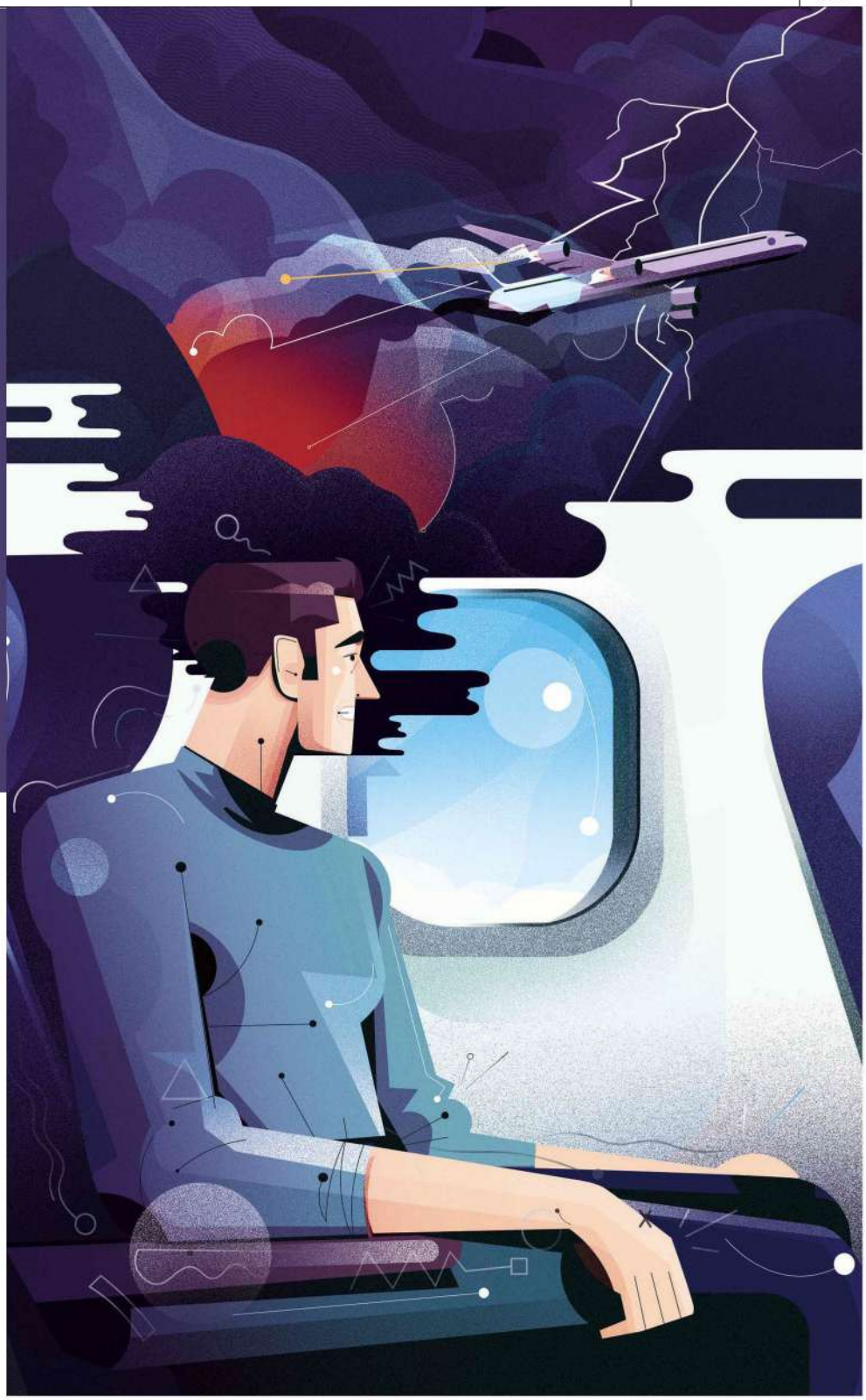
WHAT IS ANXIETY?

Essentially, anxiety is an emotional state of nervous apprehension that often involves negative and worrisome thoughts and physical jitters.

Although anxiety is often focused on a specific upcoming event or challenge, it can sometime be more diffuse – experienced as a general unease about the future. To analyse it more deeply, anxiety can be broken down into thoughts, feelings and behaviours. For instance, you think you might make a fool of yourself in a meeting; that makes you feel nauseous; and this affects your behaviour, so you decide to miss the meeting. In the short-term, dodging the meeting makes your thoughts and feelings subside but this strategy is likely to feed your anxiety in the long-term. This is a key feature of anxiety: it can provoke avoidance, that perpetuates the anxiety.

WHAT CAUSES ANXIETY?

A bout of anxiety will often start with negative thoughts about an upcoming situation. For instance, worry that an exam will be too difficult and end in failure; or that something will go wrong on a flight. These expectations can lead the brain to trigger a fear-response, which releases hormones, especially adrenaline, that activate your sympathetic nervous system. This primes your body to survive a threat – to fight, flee or freeze. If you're confronted with a truly dangerous situation, it could save your life. But you can think of unhealthy anxiety as a false alarm, one that primes your body in a way that's out of proportion to the situation. A pounding heart and adrenaline-pumped muscles aren't too useful during an exam or on a flight. Other causes of anxiety include past traumatic experiences that leave you in a permanently fearful state; certain drugs that trigger fearful thoughts or your fight-or-flight response; and medical conditions, such as hyperthyroidism, which can play havoc with fear-related hormones.



"Essentially, anxiety is an emotional state of nervous apprehension that often involves worrisome thoughts"

"Avoidance can also take the form of using unhelpful coping strategies to mask your anxious feelings – such as getting drunk to calm your nerves"

WHAT DOES IT FEEL LIKE?

Depending on the intensity of your anxiety, it usually feels unpleasant and uncomfortable, in large part due to the physical symptoms. These can include a racing heart, sweaty palms, dizziness, shakiness, stomach churn, nausea and more. Some people with chronic anxiety problems find the physical sensations associated with anxiety especially troubling and, of course, this can then feed their anxiety (imagine someone who is anxious about public speaking who gets freaked out by their shaky hands and tummy butterflies).

On the mental side, anxiety can also trigger a flood of fear-related thoughts and out-of-control worries. Combine the physical symptoms with the runaway thoughts and a common end result is a strong urge to get out of – or avoid – the anxiety-inducing situation as quickly as possible. This is what makes avoidance as a strategy so tempting, even though it's counterproductive in the long run.

WHEN DOES ANXIETY BECOME A PROBLEM?

It's completely normal to experience anxiety from time to time. In fact, in moderation in appropriate situations, anxiety can be helpful (as the boxing coach Cus D'Amato put it, anxiety is like fire: it can kill you but, under control, it's an invaluable resource for warmth and cooking). For instance, if moderate anxiety about a job interview compels you to do some preparation, that's better than just showing up and winging it. And if your mild anxiety gave you a shot of adrenaline during the interview, it might help you to think fast.

Anxiety becomes problematic when it gets out of control (you're so anxious during an exam that you can't concentrate, for example) and/or it becomes chronic and overwhelming.

A specific red flag is when anxiety starts to lead to a cycle of avoidance. For example, you might be so tied up in knots about flying that you never travel abroad. If your anxiety is so intense that you begin avoiding situations, not only is there a risk of your life becoming narrower, which might make you unhappy, but it also means you never get a chance to discover that you can cope better than you think with the situations you're worried about.

Avoidance can also take the form of using unhelpful coping strategies to mask your anxious feelings – such as getting drunk to calm your nerves. The same unhelpful process applies to this masking form of avoidance. While it might bring short-term relief, it risks fuelling your anxiety. In contrast, confronting your anxieties can be challenging in the short term, but is often the best route to easing them.

IS ANXIETY A PSYCHIATRIC DISORDER?

If a person experiences significant anxiety on more days than not over a period of more than six months, about a range of different things, then they could be diagnosed with 'generalised anxiety disorder'.

There are also types of anxiety disorder with a more specific focus. For instance, if a person has a lot of anxiety that's specifically tied to social situations, they might be diagnosed with 'social anxiety disorder'; and if a person is frequently anxious that they will have a panic attack, this is diagnosed as 'panic disorder'.

The various phobias, such as agoraphobia (a fear of places where escape is difficult), are also considered forms of anxiety disorder. Other psychiatric conditions, such as post-traumatic stress disorder (PTSD) and obsessive compulsive disorder (OCD), used to be considered forms of anxiety disorder, but psychiatrists now treat them as their own categories even though they do involve anxiety. In PTSD, the traumatised person is often left in a super-vigilant state, as if perpetually on the cusp of a fight or flight response. In the case of OCD, a person gets stuck performing checks or compulsive behaviours as an ultimately counterproductive way to reduce their feelings of anxiety.

ARE SOME PEOPLE MORE PRONE TO ANXIETY THAN OTHERS?

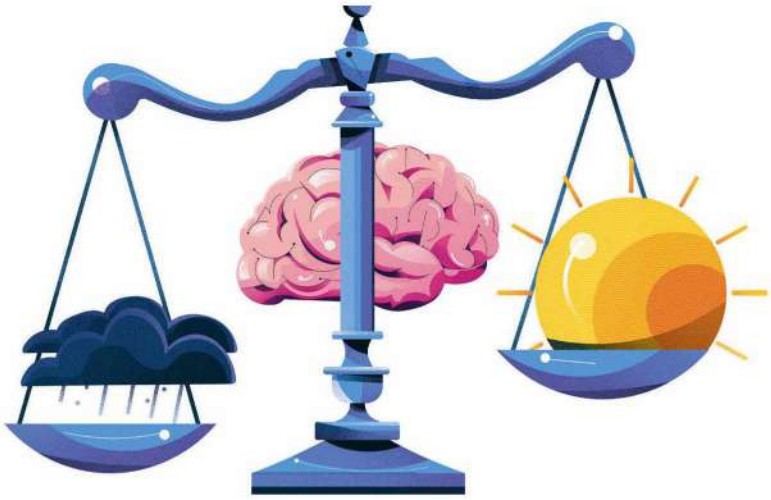
The genes we inherit and our experiences in life combine to shape our personality traits, and, in turn, these traits can affect our vulnerability to anxiety. Most of all, people who score highly on the personality trait of neuroticism tend to experience frequent ups and downs in mood, negative emotions such as shame and guilt, and they worry a lot – they're especially prone to severe anxiety.

But there are other traits that are also relevant. For instance, people who are more trusting (a facet of the broader trait known as 'agreeableness', which is associated with less stress and fewer relationship problems) are often less prone to anxiety. There's also some evidence to suggest that extroverted people tend to be less anxiety-prone, especially in a social context.

AN EMERGENCY TOOLKIT FOR WHEN ANXIETY STRIKES

Try these exercises when you feel anxiety getting the better of you

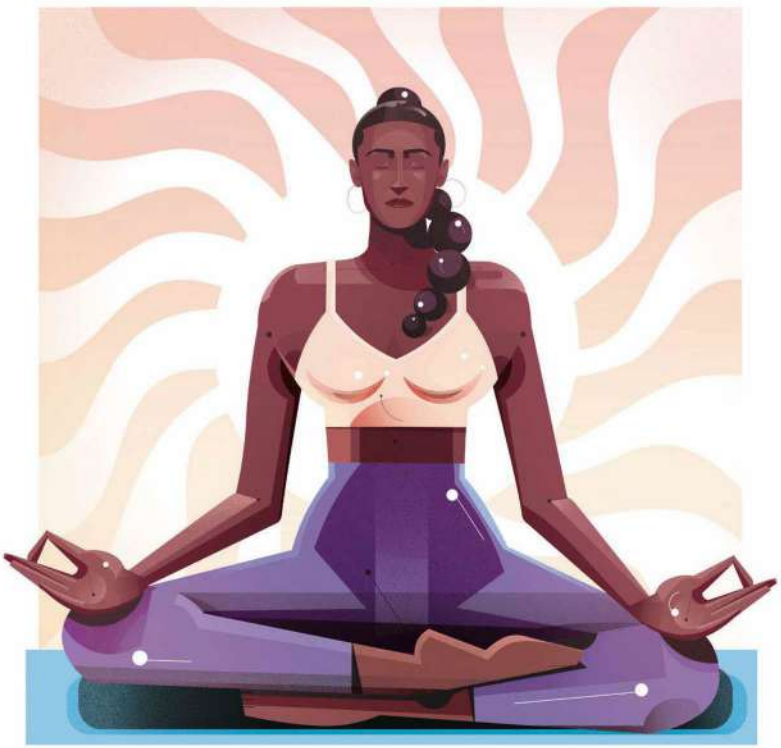
1. DISTANCE YOURSELF FROM YOUR ANXIETIES



Bouts of anxiety often begin with catastrophic thinking about an upcoming event. You start imagining the myriad ways you'll make a fool of yourself on a first date; you picture yourself tongue-tied during an interview; or you conjure vivid images of the various ways that an aeroplane can malfunction.

One way to dampen anxiety is to calm these racing thoughts. Don't do this with brute mental force – simply trying to stifle the thoughts and push them out of your mind is unlikely to work and could even backfire. Instead, try to create some distance from the thoughts, to help you realise that thoughts can be wrong and are not self-fulfilling. Say to yourself: "I am having the thought that... I am going to embarrass myself on this first date [obviously replace this with your own anxious thoughts]".

Having created this distance, calmly weigh the evidence for why you might make a fool or yourself, and then spend as much effort listing the ways that you might not. Also remind yourself of times in the past when you've coped well.



2. GROUND YOURSELF

If your mind is racing with catastrophic thoughts about what's going to happen, your body responds in kind: the sympathetic nervous system kicks in, bracing you for a threat – your breathing becomes fast and shallow, and adrenaline races to your muscles, which can cause you to tremble and feel faint.

A great way to dampen this reaction is to practise exercises that activate the parasympathetic nervous system, which has opposite effects on the body to the sympathetic nervous system, such as lowering your heart rate and blood pressure, and slowing your breathing. One exercise is called 'grounding', which helps you connect with the present moment and the environment around you, rather than being consumed by fears about the future. One popular way to do it involves pausing and naming five things you can see; naming four things you can feel; three things you can hear; two things you can smell; and one thing you can taste.

Another technique that activates the soothing parasympathetic nervous system is to stand with your feet a comfortable distance apart and lean forwards as if you're going to touch your toes – it doesn't matter how far you can actually reach – and then just hang there for a minute or so (you can also do this in a seated position by leaning forwards and allowing your head to hang comfortably between your legs). The idea behind this exercise is that it sends a strong signal to your body that all is safe, and you can relax.

3. REGULATE YOUR BREATHING

Another way to calm your body down, promote parasympathetic nervous system activity and break the anxiety cycle (in which your body's fear reaction to your thoughts makes you even more anxious) is to practise a controlled breathing exercise.

There are many different exercises you can try, but one of the simpler and more effective examples is known as 'box breathing' or 'square breathing', so called because you breath in, pause and then breathe out each for the same amount of time.

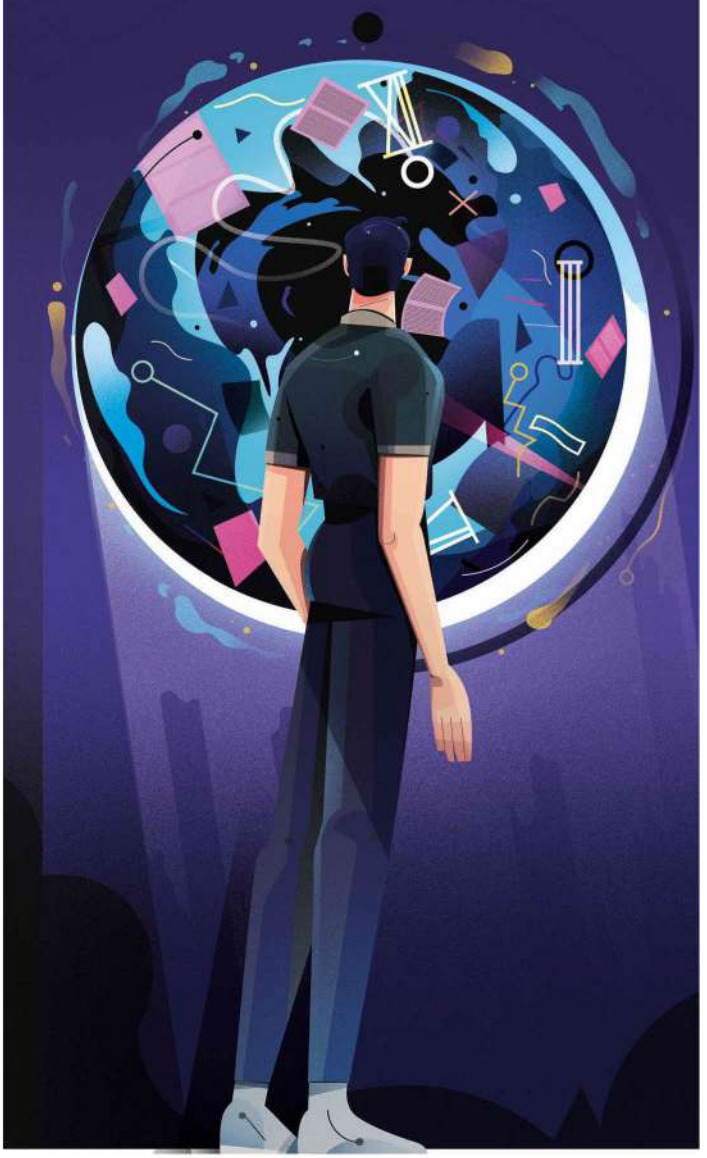
To do it, sit somewhere comfortable and focus on your breath. Inhale for four seconds, pause for four seconds, then exhale for four seconds. Try to repeat this for at least 30 seconds and continue for as long as you feel comfortable or for as long as you need. The idea is that this will help to get your breathing rate and depth back under control, which is an effective way to calm the entire body.

4. PLAN A 'WORRY WINDOW'

If you find that your worries keep coming back, even after you've calmed your mind and body, it can be very unsettling and give you the sense that you're stuck in a loop. You might even come to form unhelpful beliefs, such as that you need to engage in worry to try to 'solve' a dilemma or to prevent a bad thing from happening – these are known as 'meta-cognitions' because they're your beliefs about your thoughts.

However, unless you're forming genuine solutions or constructive plans in your mind, then churning the same worries around and around is futile, like a car's wheel spinning in the mud. Trying to banish these worries from your mind is unlikely to work.

A better approach is to plan a 'worry window' – a set period of time, about half an hour or so (ideally not too close to bed-time) when you'll allow your mind to give vent to its worries. The rest of the time, whenever your worrisome thoughts surface, you can remind yourself that you'll be turning your attention to them later. This can be an effective way to break out of a perpetual worry loop and allow you to get on with your life.



LONG-TERM TOOLS TO LESSEN YOUR ANXIETY

1. CONFRONT YOUR FEARS

It's natural to want to avoid the situations that make you anxious but, in the long-term, this is only likely to fuel your anxiety. When you avoid anxiety-provoking situations, not only do you risk missing out on opportunities in life, but you never get to 'reality-check' your worst fears – for instance, to go on a date without it being a disaster, or fly on a plane and find that it stays in the air.

Unconfronted fears can grow and fester, assuming an out-of-proportion aura of doom. In contrast, when you face your fears and find that the worst doesn't happen, psychologists call it an 'expectancy-violation'. You burst the baleful balloon. By undermining your negative expectations like this, you gradually teach your brain to be less anxious. The technical term for confronting your fears and anxieties is 'exposure'. It's a good idea to start gradually. Choose a situation or challenge that you only find mildly anxiety-provoking and give it a go (using your emergency tool-kit before, during and after as appropriate). If a real-life exposure is too daunting – you can even try doing it in your imagination.

2. EXERCISE REGULARLY

Building opportunities for physical exercise into your lifestyle isn't only good for your body, it's good for your mind too. Studies have shown that exercise can boost mood and stave off depression. People who are more physically active also tend to show benefits to their personality traits years down the line, including keeping their neuroticism in check. Other research shows that regular exercise can help prevent the risk of developing an anxiety disorder.

There are many reasons why exercise has these benefits, including distraction, camaraderie and improvements in physical health – which can break the known links between poor health and anxiety.

Yet another reason why exercise – especially vigorous exercise – is a great tool for beating anxiety is that it can get you used to the kind of physical sensations that fuel anxiety, such as a racing heartbeat and a feeling of breathlessness. If you're used to these sensations in your weekly run or boxercise class, they won't be so disconcerting the next time you have to give a speech or go for a job interview.

3. GO EASY ON THE CAFFEINE

Whether it's in your morning espresso or an energy drink at the gym, caffeine might be such an integral part of your routine, that you don't stop to think that it's actually a psychostimulant – a drug that acts on the brain. Specifically, caffeine acts to block the brain chemical adenosine, which usually serves to calm us down physiologically, such as by lowering our blood pressure and slowing our breathing. This neural action is great in terms of making us feel more alert and hyped up but not welcome at all if you're prone to anxiety.

So, one modest lifestyle change to make over the longer term to reduce your anxiety levels is to consume less caffeine, remembering that it's also present in chocolate and tea. Indeed, if you're an anxious person and you currently consume an excessive amount of caffeine, it's feasible that it could contribute significantly to your problems – psychiatry even recognises 'caffeine induced anxiety disorder' as a subtype of the formal diagnosis of 'substance or medication induced anxiety disorder'.

4. CONSIDER YOUR LONG-TERM RELATIONSHIP WITH ANXIETY

If you come to believe that being anxious is a fundamental, permanent part of who you are, then whenever you're confronted by situations that make you feel uneasy or afraid, you're more likely to succumb to the discomfort and withdraw as quickly as you can.

In contrast, if you can try to see anxiety as a temporary, fleeting state – one which is part of being human and can affect anyone at any time – then you're more likely to find the motivation to ride out the discomfort and seek more constructive ways to deal with it. Psychologists call this latter perspective a 'growth mindset' as opposed to a 'fixed mindset'.

You might have heard these terms used in relation to intelligence and learning, but emerging research suggests the distinction also applies to how we think about our experiences of anxiety. So, consider your relationship to anxiety and remember it can be useful and it can be tamed.

by DR CHRISTIAN JARRETT
Christian is a psychologist and writer. He is the editor of Psyche, *the sister magazine to* Aeon. *His latest book is* Be Who You Want *(£14.99, Robinson).*

MENTAL HEALTH IS OTHER PEOPLE

WORDS: KELLY OAKES

Enjoying the weather? Did you see the game? Small-talk and simple face-to-face interactions have a bigger effect on our wellbeing than you might think. So, do you fancy a cuppa?

Dr Gillian Sandstrom was at the opera when she realised how good she had become at talking to strangers. A woman with Parkinson's was feeling anxious and needed an aisle seat and when Sandstrom noticed what was happening, she asked a whole row of people to move along to make room for the woman and her husband.

"As the couple moved past me the husband said, 'Thank you so much, I could never have done that,' and I thought to myself, 'past-Gillian couldn't have done that either'," she says. "But now, it's not a big deal."

For Sandstrom, a senior lecturer in the psychology of kindness at the University of Sussex, talking to strangers didn't always come naturally. But her research looks at the benefits of those small, day-to-day interactions and so, over the course of her career, she has had plenty of practice. Now, it's a skill she's glad she cultivated. "I would feel like a hypocrite if I didn't talk to strangers, so I do it a lot," she says. "The biggest benefit is I'm just not nervous about other people anymore."

"IT ISN'T JUST OUR PHYSICAL HEALTH THAT SUFFERS FROM A LACK OF SOCIAL CONNECTIONS"

BODY AND MIND

We all know that a balanced diet and exercise are important parts of staying healthy. But a growing body of research is showing that there's another factor that's even more important for keeping us in good shape, both physically and mentally: our social connections.

A landmark study published in 2010 found that the quality of someone's relationships is a bigger predictor of early death than obesity and physical →

GETTY IMAGES ILLUSTRATION: ANDY POTTS

→ inactivity, and on a par with smoking and alcohol consumption. "The size of these effects really can't be overstated, they're enormous," says Tegan Cruwys, an associate professor and clinical psychologist at the Australian National University.

Of course, it isn't just our physical health that suffers from lack of social connections. Other research shows that having a strong romantic relationship leads to better mental health and that feeling connected to others decreases symptoms of depression, mitigates symptoms of post-traumatic stress disorder and improves overall mental health.

But while we might have reluctantly come to accept that a regular physical fitness regime is required to maintain a healthy body, it can be easy to sink into the assumption that our relationships will maintain themselves. Research shows that that's not true: we should all be thinking as much about social fitness as we do about physical fitness.

Robert Waldinger, professor of psychiatry at Harvard Medical School, runs the Harvard Study of Adult Development, a decades-long study on health and wellbeing. "What we found was that perfectly good relationships will often wither away from neglect and that the people who were best at having vibrant social networks were the people who took care of them, the people who were actively maintaining their connections with other people," he told the *BBC Science Focus Instant Genius podcast*. "That's why we coined the term social fitness, to be deliberately analogous with physical fitness."

As part of the Harvard study, researchers asked participants to list who they could call during a middle-of-the-night emergency. Most wrote down several people but some participants couldn't even list one. Not having that psychological safety net puts us in a vulnerable position. "When you're lonely, you're in a state of fight or flight all the time," says Marisa G Franco, psychologist and assistant clinical professor at the University of Maryland, and author of *Platonic*. "It's like putting your body under a chronic stress state."

"RESEARCH SHOWS THAT GROUP-BASED SOCIAL CONNECTIONS SEEM TO BE MOST IMPORTANT FOR OUR COGNITIVE HEALTH"

But social connections of all shapes and sizes contribute to our wellbeing. While a romantic relationship or close-knit group of friends might make us feel safe, the fleeting interactions we have with people we don't know well can bring us a different kind of joy. "They're a source of spontaneity and novelty that we don't get in the same way from our close relationships," says Sandstrom. For example, the questionnaire she used in her research showed that people who had a brief chat with a barista were happier than those who were as efficient as possible

GETTY IMAGES X2. ILLUSTRATION: ANDY POTTS

ABOVE A little interaction with other people helps people feel more connected

LEFT Joining a group, such as a community garden scheme, could help people with depression

when buying their coffee. "People are in a better mood when they have this little social interaction, they feel more connected to other people," she says.

In fact, research shows that group-based social connections, rather than individual relationships, seem to be most important for our cognitive health. There's also research which shows that joining groups – such as belonging to a church or working on a community garden – can be an effective treatment for depression. Following 4,000 adults in England over six years, Cruwys found that not only did joining a social group alleviate symptoms of depression and reduce the risk of relapse, it also protected against future depression.

The feeling of connection to others and the wider world appears to be the active ingredient that makes social connection so good for our wellbeing. "We think that it's actually these group ties, these social identities that are at the heart of why social connection is so important for health," says Cruwys. "While a one-on-one tie, a friendship, might be really nice and pleasant, and you might enjoy that time, it's not changing how you see yourself in the way that being part of something bigger does."

CONNECT WITH SOMEBODY

The ideal social life will, of course, vary between people. So when it comes to assessing your own social fitness the key thing to consider is whether the connections you have at the moment are meeting your needs. Do you have plenty of friends but lack that feeling of being connected to something bigger? Or are you heavily involved in your community, but long for a close friend to confide in? →

7%
of adults in the UK say they don't have any close friends

18-24
is the age group that feels most lonely in the UK

17%
of people say they're pleased when social plans get cancelled, but 36% say they're disappointed

4.1
is the number of intimate relationships someone can maintain at once, according to work by emeritus professor of evolutionary psychology Robin Dunbar

88%
of adults in the UK say they can rely on people in their lives if they have a serious problem

→ If you do decide you need more friends, you should be prepared to make the first move. "One problem with friendship is that we assume that it happens organically and it doesn't, in adulthood," says Franco. She recommends starting by reconnecting with someone from your past. "The most common reason friendships end is simply because we fall out of touch rather than because there's any fundamental difference between us," she says.

Alternatively, you could join a group or class that's repeated at regular intervals over time. And simply by sticking with it for at least two months you can capitalise on something called the 'mere exposure effect', which is our tendency to like people who are familiar to us. "At first, it's going to be uncomfortable and awkward," says Franco. "I think the problem we have is that we assume that it's always going to be that way and we quit in that early phase."

"IF YOU DO DECIDE YOU NEED MORE FRIENDS, YOU SHOULD BE PREPARED TO MAKE THE FIRST MOVE"

Sticking to a familiar routine is also a good way to form so-called 'weak ties' – social connections with people who are not quite strangers, but not (yet) friends either. Head to the same café each Saturday afternoon or walk your dog on the same route each morning and

CONVERSATIONS WITH STRANGERS

PSYCHOLOGY OF KINDNESS LECTURER, DR GILLIAN SANDSTROM, HAS SOME USEFUL POINTERS FOR HOW TO STRIKE UP A CONVERSATION WITH SOMEONE YOU DON'T KNOW...

CHOOSE YOUR TARGET WISELY

"Talking to someone with a dog or a baby is a little less scary somehow and it's more acceptable," says Dr Gillian Sandstrom. Plus, it gives you an instant conversation starter.

SELECT YOUR TOPIC

The weather is a classic conversation opener for a reason: it's something we all have in common. The space you're in is another potential opener. "I often talk to people while I'm waiting in a queue because we're waiting for the same thing, or I'll talk to people sitting next to me at a concert or a show," she says. You can also point out something they might not have seen. "When the crocuses are starting to pop up in the spring, I might ask someone: 'Oh, did you see the crocuses over there?"

ASK SOMEONE A QUESTION

At a coffee shop, you might ask the server what they recommend. Or simply tap into your own curiosity. "I've been on the Tube and seen multiple people wearing the same T-shirt because they were doing some kind of race, so I asked about the T-shirt," she says.

DON'T EXPECT THE WORST

These conversations tend to go a lot better than people expect. "All the things that people worry about – and there's lots of things that people worry about – they just don't really happen very often," she says. Plus, there's something called the 'liking gap': research shows that, after a conversation, people tend to like us a lot more than we think they do.

GETTY IMAGES X2, GILLIAN SANDSTROM ILLUSTRATION: ANDY POTTS

LEFT A few moments of small talk with shop staff, or other people queuing around you, could put a spring in everyone's steps

BELOW LEFT Dr Gillian Sandstrom explores the psychological benefits of small, face-to-face interactions

you'll likely start to see some familiar faces. "When we're in situations with other people, and we see those people again and again, we're more likely to start up conversations with them, and some of those conversations are likely to deepen and perhaps eventually become friendships," says Waldinger.

TALK TO STRANGERS

If setting out to make a new friend sounds too daunting, build your confidence by talking with strangers. Sandstrom ran a study that involved a scavenger hunt-style game where people had to find and speak to new people repeatedly. "Over the course of the week, day by day, people got more and more confident in their conversational abilities," she says.

But a week-long crash course in talking to strangers is not a social fitness requirement. Nor is the ability to join a new evening class for every day of the week. "It's not about the amount of contact we have with people, it's much more about the quality of that contact and that sense of belonging that we derive from it," says Cruwys. "There are ways we can stay connected and feel that sense of belonging without having it take up a huge amount of our time."

Digital technology can help – if you're intentional about how you use it. Research shows that using social media

to maintain existing relationships can reduce loneliness but if it displaces offline activities, it makes us more lonely. Passive consumption – scrolling through feeds without interacting – might even trick us into feeling like we've ticked the social connection box, when we haven't. "It gives us a snack of connection so we don't even realise how lonely we are," says Franco.

Of course, as with physical fitness, often there are forces beyond our control that make it harder to maintain social connections. "The people who are most lonely in our society often have some real barriers to being connected," says Cruwys, such as people with disabilities and those living in poverty.

By engaging in small acts to help bring about social connectivity, we could also end up helping people more in need than ourselves. In Australia, a grassroots initiative called Neighbor Day involves people setting up community events such as jumble sales or street parties, or even just WhatsApp groups for their street. Cruwys studied the impact this initiative had during a COVID-19 lockdown period, when people's social lives were curtailed. "We found that people who hadn't been involved in Neighbor Day showed a decline in their wellbeing during that lockdown period, but people who had been involved in Neighbor Day didn't," she says.

Similarly, the act of talking with a stranger could put a spring in your step for the rest of the day – and do the same for the other person, too. "This has a lot of benefits for you," says Sandstrom. "But it's also an act of kindness." **SF**

by **KELLY OAKES**
(@kahoakes)
Kelly is a science writer who covers science, tech, health and the environment

PATIENT, DIAGNOSE THYSELF!

MENTAL HEALTHCARE IS IN SHORT SUPPLY. IN ITS PLACE, WELL-MEANING ONLINE COMMUNITIES HAVE SPRUNG UP OFFERING SUPPORT, ADVICE AND EVEN DIAGNOSES TO THOSE THAT NEED IT. BUT IS THIS SAFE?

WORDS: DR DEAN BURNETT

ILLUSTRATION: ELENA CALOFARO BANSH

If you're struggling with your mental health, what are you meant to do about it? Thanks to many campaigns dedicated to it, 'awareness' of mental health concerns is rising all the time. And that's good. Awareness is only the beginning, however. It's all well and good to tell people it's 'time to talk', or to insist there's no shame in asking for help, but what if that help isn't forthcoming?

This isn't a hypothetical. For years now, UK mental healthcare has been in a poor state, as damning statistics show. 40 per cent of mental health trusts are dangerously understaffed. Just 14 per cent of crisis patients report receiving all the care they need. Waiting times often stretching to over a year mean 75 per cent of mental health patients have to resort to emergency services, which are already overstretched and ill-equipped to deal with such cases. And despite mental health problems affecting 1 in 6 people, and getting progressively worse all the time, there's shockingly little enthusiasm from those in power to deal with the issue in any meaningful way, beyond trite slogans and empty promises.

As a result, it's no wonder that many people end up looking beyond established healthcare systems for help and support. Whether it be via patient communities, online resources, new technologies, alternative therapies, or whatever, you can't really blame people for taking their mental health matters into their own hands. Because what choice do they have?

An unavoidable outcome of this, however, is that many people who, via the use of the resources they do have access to, end up figuring out their own diagnosis and what to do about it. This is →

→ arguably just another manifestation of self-medicating, a practice that's been around since before mainstream medicine. Unfortunately, self-medication can often make matters worse. Consider how many addictions stem from someone desperate for relief from a pre-existing malady.

The point is, while self-diagnosis of mental health issues is both inevitable, and in many cases essential, it's often overlooked how, thanks to the way our brains work, it can have negative, harmful outcomes. Particularly in our modern technological world.

THE DIFFICULTY OF DIAGNOSIS

Experiencing a mental health issue is hard enough on its own, but not knowing what it is creates a great deal of uncertainty, which causes our brains considerable stress. And stress is a key factor underlying many common mental health issues. So, anything that removes or reduces uncertainty can help alleviate the resultant stress.

A medical diagnosis is one way to achieve this. If the ensemble of debilitating thoughts or disruptive moods you're experiencing suddenly has a name, and a range of specific criteria determined by the world's leading experts, that's reassuring. It can make people feel that their problems are both normal and understood.

But diagnosing a mental health condition is a tricky, complex process, even for trained professionals. Hence, when enthusiastic 'armchair experts' stick their oars in, it rarely ends well.

If people end up adapting and altering their behaviour to better deal with a mental health self-diagnosis, however it's arrived at, that's understandable. But what if that diagnosis is wrong? It may still provide a comforting relief from uncertainty, but any changes made based on it can make matters more confusing, if not actively worse.

For instance, someone may self-diagnose depression and subsequently persistently fight against, or ignore, their 'irrational' negative feelings. Makes sense, right?

But what if they've actually got bipolar disorder? Even trained professionals regularly misdiagnose that. And if there's one thing that'll make a manic episode worse, it's suppressing any feeling that you're doing something wrong.

That's a very crude example, but the complex, variable nature of mental health disorders (and how effective interventions can be) means self-determined diagnoses and interventions could end up in any number of unhelpful places.

> "DIAGNOSING A MENTAL HEALTH CONDITION IS A TRICKY PROCESS, EVEN FOR PROFESSIONALS"

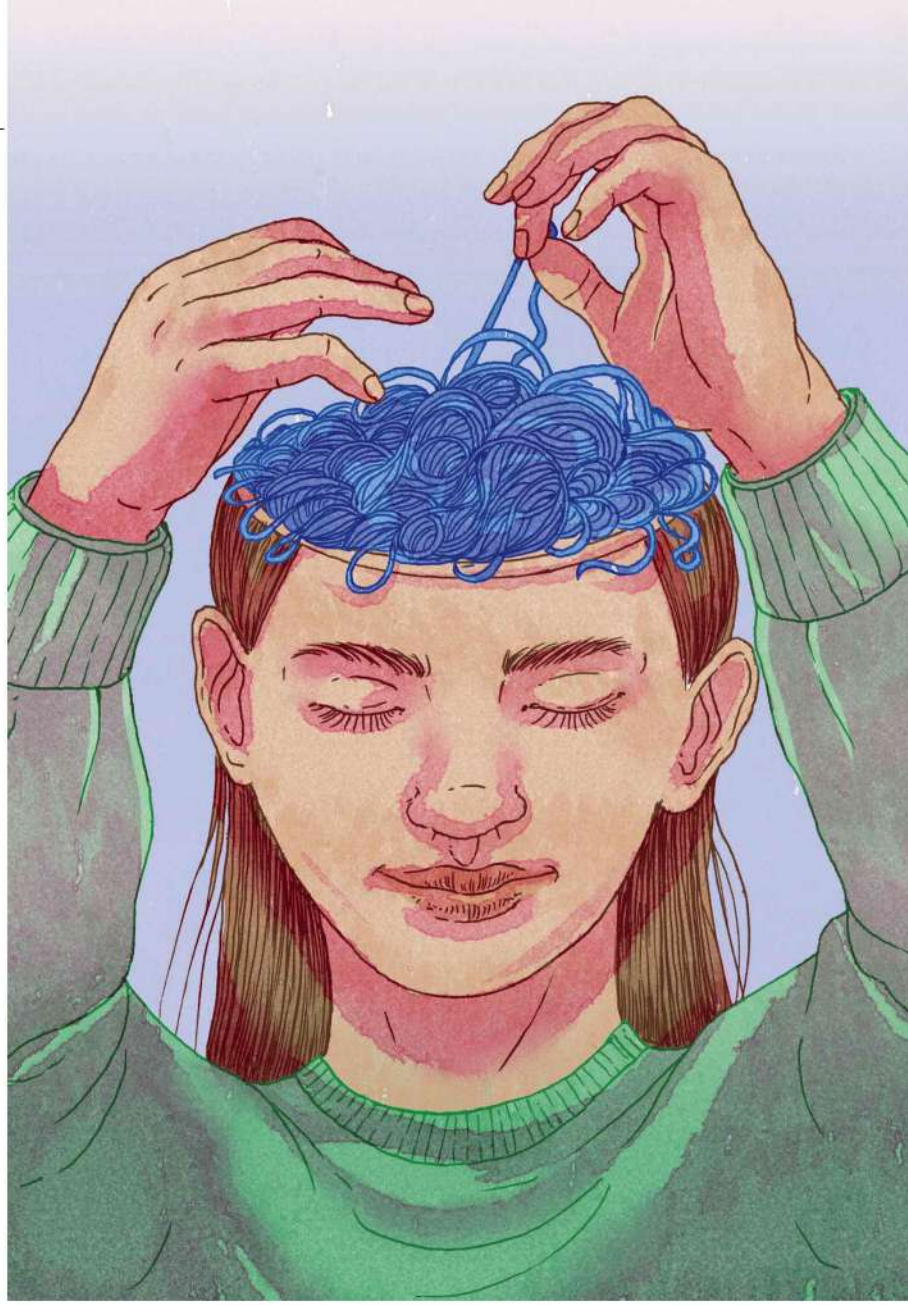
WORST-CASE SCENARIOS

Even with the best intentions, expecting someone with mental health issues but zero clinical training to be objective, thorough and rational, while wading through vast swathes of complex, often-conflicting information, in an attempt to self-diagnose, is a considerable, and unreasonable, ask.

Among other things, people will inevitably be prone to confirmation biases – even extensively trained clinicians are. It means that, when searching for answers, information that matches what people want to hear, and/or what they already think, will be perceived as more 'correct'. The self-diagnosis they end up with will be the result of such flawed analysis.

This won't necessarily be a 'positive' bias. As anyone familiar with the 'Doctor Google' phenomenon will know, people self-

ILLUSTRATION: ELENA GALOFARO BANSH



diagnosing often gravitate towards a worst-case scenario. This may stem from the typical brain's inherent negativity bias, where negative or dangerous possibilities instinctively attract the most attention. Our brains self-defence mechanisms are constantly looking for the greatest threats and risks. That's why you latch on to 'three weeks to live' rather than 'moderate allergic reaction' when googling your symptoms.

Also, depression, the most common mental disorder, amplifies this negativity bias, so arriving at an unhelpful worst-case scenario self-diagnosis is an even more likely outcome.

SELF-DIAGNOSIS, SELF-WORTH

Mental health stigma, while in decline, is still very much a thing, especially in certain less-liberal cultures or communities. Among other things, it means those experiencing mental health problems end up with less help and concern than they legitimately need, which exacerbates matters. But as well as this, humans are intensely social creatures, meaning we find rejection psychologically painful and distressing, to the extent that it can make mental disorders and issues even worse.

Patient communities are an important aspect of the modern mental healthcare experience. One of the positives of the internet and social media is that they readily connect vulnerable and isolated people, who can now easily, and safely, share their experiences with like-minded folk who've gone through similar things. The benefits of this can't be overstated.

But while such communities can be a vital lifeline in helping people deal with their condition, being part of a large, enthusiastic, like-minded group has weird effects on humans.

The group or community we feel part of most regularly becomes an integral part of our identity. But because we want to impress the others we identify with, we tend to amplify and exaggerate the qualities we have that the group approves of, so as to increase our status. If we're part of a weight-loss group, we work harder to lose the most weight. If we're involved in a *Star Wars* fan community, we go out of our way to show that we love *Star Wars* the most.

Unfortunately, this can lead to irrational, even harmful extremes. There are countless examples online of prominent figures, from across the ideological and cultural spectrum, who went from being relatively normal to disgorging the most baffling or hateful views, thanks to years of constant reinforcement from their supporters and peers who agree with and encourage, and therefore reinforce, such things.

Mental health communities are just as vulnerable to this phenomenon as any others. Many will know of at least one person whose mental health issues have gone from 'a problem they'd like to have addressed' to 'the main aspect of their identity'.

There's nothing inherently wrong with this, but it can lead to unhealthy places. Dismissing therapies or other interventions, exaggerating symptoms, setting a bad example to other vulnerable types. Who knows what else.

It can certainly muddy the waters further for those in vulnerable states looking for insight into their own potential issues. Thinking 'This diagnosis would explain what I'm experiencing' can be less persuasive than 'This other diagnosis would mean I'm accepted and liked by this particular group'. And that's not necessarily a better option. →

→ History is rife with examples of mass psychogenic illness, where symptoms spread through a population, despite having no pathogen or organic cause. These usually take the form of physical disturbances (dancing, fainting, screaming, for example) and they occur exclusively in populations that are in close physical proximity.

Until now, it seems. Recent reports reveal a psychogenic phenomenon where young girls displayed Tourette's-like tics, despite having none of the signature traits of Tourette's. The consensus is that the cause of these symptoms is actually TikTok, as many of the girls afflicted report having watched videos of influencers who claimed to have Tourette's and displayed the traits.

GROWING MINDS

Before anyone starts crowing about how social media is corrupting the youth, this isn't that surprising.

Humans subconsciously mimicking others' movements, gestures and speech is an everyday occurrence, thanks to the way our brains work.

On top of this, adolescents, a major TikTok user base, are in a key stage of neurological development. Their emotions are powerful, their mental wellbeing is vulnerable, they're still figuring out and forming their overall identity, and are especially sensitive to peer approval.

So, when faced with a charismatic, sympathetic, relatable, engaging stranger with a prominent platform (which is to say many a mental health influencer), adolescents are particularly likely to respond strongly to them and, perhaps unintentionally, emulate them. And if said influencer displays physical traits, such as tics... It's basically a perfect storm for flawed self-diagnosis.

And yes, Tourette's is a neurological condition, not a mental one. But the neurological, the psychiatric and the neurodivergent are often used interchangeably online, which confuses matters further.

This reveals another aspect that warrants concern: when people try to self-diagnose, where is their information coming from? For professional clinicians, there are many rules and regulations in place, and diagnostic information has to be approved by countless experts.

Online... Not so much. If you're watching a mental health influencer explain things on TikTok, are they a trained professional? Someone with extensive lived experience of a condition sharing their perspective? Or maybe even someone exaggerating (or actively lying about) a condition for clicks and reactions? Telling them apart is an increasingly big problem. And there's seemingly very little oversight of this issue, on any of the major social media platforms. How is anyone meant to accurately self-diagnose when the people they're getting their insights

ILLUSTRATION: ELENA GALOFARO BANSH

from are giving out skewed or unreliable information? Or those people are more concerned with boosting their image, no matter what effects it may have on the mental wellbeing of others?

This is important, because a flawed self-diagnosis is potentially harmful. Not just because it may lead to unhelpful behaviours and thinking, but because there's evidence implying that emulating a mental health condition, for whatever reason, can actually lead to developing it for real. That's the thing with mental health issues: if you genuinely believe it's a problem, then, to a not-insignificant extent, it is.

WHAT CAN WE DO?

So, an inaccurate self-diagnosis can lead to a number of bad outcomes, including developing that wrong diagnosis for real.

Thankfully, there are a few possible ways to intervene here. For one, if an individual can be made to recognise and accept that their self-diagnosis is 'inaccurate', it can enhance the efficacy of the treatments administered for it.

But even if that doesn't work, if they become convinced that a certain mental health diagnosis is correct, then the treatments for that diagnosis are seemingly also effective, whether they be cognitive, pharmaceutical, or any other type of intervention.

In truth, though, the underlying mechanisms of psychogenic disorders are still being studied, so the evidence base for effective treatments of them is rather limited.

As such, prevention would be a better approach than cure. Greater oversight of social media and other platforms, to prevent the misinformed or ill-intended distorting the important information supplied by relevant experts, or at least enhancing the ability to tell such people apart, would be a good start.

And in general, more reliable, robust but accessible resources of data and insights about mental health, which are both engaging and comprehensible to the lay person seeking answers, may help improve matters further.

This will hopefully be enhanced further by the introduction, and more widespread adoption, of therapeutic software. Several new digitally enabled therapies have recently been recommended by the National Institute for Health and Care Excellence (NICE). If these, and others in development, become more normal, it would mean people with mental health issues have much better access to professional and effective resources, without having to leave their homes.

The issues and problems of self-diagnosis via the internet would obviously be less prevalent, if the same internet also made robust and reliable mental health tools more readily available, and identifiable. Let's make one thing clear, however: from the many years of the 'disease model' being dominant in psychiatry (meaning patients had to take a passive, submissive role in their treatment), to the fact that it was only a few decades ago that homosexuality was officially deemed a mental illness, the medical approach to diagnosing mental health conditions has been far from perfect.

Many have reservations about the inflexible and limited approach of medical diagnosis, and rightly so. Some of them are clinical psychologists, who take a markedly different approach. So, even if the medical mental health system were fully funded and accessible (which it very much isn't), self-exploration and analysis by the individuals affected by mental health issues would still be very helpful, if not essential.

"MANY HAVE RESERVATIONS ABOUT THE INFLEXIBLE AND LIMITED APPROACH OF MEDICAL DIAGNOSIS, AND RIGHLY SO"

But, as we've seen, self-diagnosis comes with risks. The medical approach may not be perfect, but it doesn't automatically follow that you should throw the baby out with the bathwater. In an ideal world, medical understanding and oversight would exist in perfect harmony with the individual journeys and explorations of patients, working together to understand, diagnose and deal with mental health conditions. Of course, in a perfect world, I wouldn't even need to point that out. That's my diagnosis, at least. **SF**

by **DR DEAN BURNET**
(@garwboy)

Neuroscientist Dean discusses the contagion of emotions and disorders via technology in greater depth in his latest book, Emotional Ignorance *(£14.99, Guardian Faber).*

IS SOCIAL MEDIA RUINING CHILDHOOD?

Words PROF PETE ETCHELLS Illustrations SAM BREWSTER

It's tempting to think that our digital lives on TikTok, Instagram and Snapchat are at fault, but there might be something altogether more analogue going on, says Prof Pete Etchells

What do we really know about the relationship between social media and teenage mental health? I ask because the other day, my daughter asked me if she could have her own phone. She's only three years old, so the request caught a little off guard. This wasn't a conversation I was expecting to have until she becomes a teenager.

'You're too little to have a phone yet,' I said to her. 'Why do you want one?'

No clear reason was forthcoming, save for a beautiful stream of consciousness that one of her friends at nursery had a friend at school who was four and had a phone, and because three is nearly four could she, my daughter, have one. I gently explained to her that this is something we could talk about when she was older, and although not quite content with an answer that was essentially 'no', she wandered off to start her next adventure of the day.

That conversation left me with two feelings. One was a slight air of confusion – what sort of phone had we been talking about? I had assumed it was a smartphone and I was wracking my brains to come up with a reason why a four-year-old might need one. But maybe we'd just been talking about a toy, in which case, my daughter already had a phone – many, in fact, if you include things like bananas, pens and the shower attachment on our bath.

The other feeling was unease. Digital technology is a necessary part of our lives – smartphones, social media, even video games are the primary ways we interact and connect with people. And while it's inevitable that our kids will join that digital space, for many of us, those technologies are a sort of Pandora's box. There's something about them that feels bad and so providing access to them, while it might have some benefits, feels like a disaster waiting to happen.

These fears are driven, in part, by a seemingly relentless parade of articles in the news highlighting the detrimental effects that digital technologies have on us. But such articles mesh with our own experience, because we've all had bad days online. It's easy – and understandable – to feel that screen technologies just haven't got our wellbeing at heart.

Reinforcing this sense of unease is the fact that there are some real causes for concern about mental health, particularly when it comes to children and adolescents. Across a range of recent scientific studies, the trends seem clear: over the past decade or so, there has been a noticeable increase in mental health issues in UK and US teenagers.

For example, a 2021 study of patient data from nearly 2.5 million UK teens showed that for nearly every age group, anxiety and depression rates have been increasing, with a particularly striking increase in anxiety disorder rates for girls aged 13-19 that seems to start around 2012. Further data from the US-based Youth Risk Behaviour Survey (YRBS) points to similar concerns: on average, there have been steady increases in both depression and suicide risk since 2011, with rises being much more pronounced in girls than in boys. Something seems to be going seriously wrong with teenage mental health.

"Over the past decade or so, there has been a noticeable increase in mental health issues in UK and US teenagers"

WHAT'S TO BLAME?

Trying to pinpoint exactly what's causing these issues isn't easy but over the past few years a number of psychologists and journalists have focused on digital technology – in particular, social media – as the driving factor.

Perhaps the most prominent example of this was in 2017, when, in an article published in *The Atlantic*, psychologist Dr Jean Twenge suggested that the points at which we start to see steeper rises in various measures of poorer mental health appear to coincide with the advent of the iPhone, around 2007. It's a compelling point: if you produce a graph plotting, for example, the percentage of US teens who agree with the statement 'I often feel left out', and then draw a vertical line through 2007, the data look fairly flat prior to that point, and then skyrocket afterwards. The same is broadly true for other similar statements, as well as overall depression scores.

The article, titled 'Have smartphones destroyed a generation?', was one of the most widely shared science opinion pieces that year and has had an influential effect on the wider debate about the relationship between digital technology and mental health ever since. So much so, that we saw a similar argument made in the *Financial Times* recently – although this time, the headline was much more assertive ('Smartphones and social media are destroying children's mental health'), and the trendline graphs were segmented into pre- and post-2010, which was loosely labelled as 'the smartphone era'.

BUILDING BIAS

Scary headlines like this are unhelpful for two reasons. The first is that because of a lack of consistency in research findings, we don't know whether the worries they stoke are proportionate or directed appropriately. The second is that they risk feeding into what researchers call 'the influence of presumed influence' (that is, because we're repeatedly exposed to news stories telling us that screens are bad for us, it becomes the assumption that drives our behaviours and attitudes towards them and, potentially, our responses in studies asking us to report on our digital behaviours – as opposed to our actual experiences).

So, while research and the associated public discussion has trudged on since then, unfortunately we haven't made much headway in terms of more deeply →

→ understanding the relationship between social media and mental health. Some studies do find clear links, others don't; some find links but only in some situations and sometimes, different studies find different results even though they're based on the same data.

Part of the reason for that is that most studies in this area are necessarily correlational in nature – they take big long-term datasets, like the YRBS, and try to see whether there are any statistically significant relationships between the rise in social media, say, and different measures of mental health. But while these sorts of datasets are hugely powerful entities, they don't allow us to get any closer to understanding whether those relationships are causal in nature.

And as to why we find such disparate findings, research published in 2019 suggests that whether or not we find correlations in the data has more to do with how researchers' biases influence data analysis, as opposed to whether there's an actual signal in the data. The study, from the Oxford Internet Institute, showed that in datasets like the YRBS, there are a huge number of questions that are asked about digital technology use, wellbeing and other factors that can impact both. It's what makes these sorts of surveys so powerful from a scientific perspective: because of the vast amount of data they collect, you can ask questions about almost any aspect of human behaviour.

But it also means that the number of sensible and theoretically justifiable ways in which you can combine measures of tech use and wellbeing to ask a meaningful question about how they're linked can, in some cases, run into the trillions.

Without due care and attention then, researchers may unwittingly fall into the trap of running multiple analyses until they 'find' the answer they think they wanted in the first place. That means it's incredibly important to have a sound theoretical base for asking those questions in the first place, which is something we don't really have at the moment.

It's a fact that speaks to a more fundamental issue, one that both researchers and journalists need to address before we can make any progress in understanding what's going wrong for teenage mental health. That issue, I think, is that we're asking the wrong questions about the role that digital technology and social media has to play.

CORRELATION IS NOT CAUSATION

It's hard not to get seduced by the figures published in the *Atlantic* piece in 2017, and in the *Financial Times* earlier this year – there's so clearly a shift in mental health issues around 2007-2010 that there must be a causal connection with the advent of smartphones. But we need to be wary of coincidences.

But 2007 also saw the onset of a global financial crisis, as well as the launch of the Foo Fighters' album *Echoes, Silence, Patience & Grace*. One of these things makes sense to consider in the context of long-term effects on mental health; the other doesn't. But we could quite happily draw a line through 2007 on a graph of mental wellbeing, label it as either 'financial crisis' or 'Foo Fighters' and infer a link.

We need to be mindful, then, that mental health issues are complex and nuanced, and are therefore never going to be explained by a single, simple factor (or multiple factors that are all referred to interchangeably – smartphones and social media are very different things).

Alongside the rise in social media use, other possible factors that have been cited in the literature include: increases in parental mental health issues; reductions in stigmatising attitudes and behaviours towards mental ill health; a general increase in awareness about their existence; changes in diagnostic criteria; financial difficulties; educational stressors; and more. So instead of asking: does social media use cause mental health issues?, perhaps a better question might be: why do some people prosper online while others get into real difficulty?

There's growing research evidence that suggests our online lives reflect our offline lives in important and sometimes indiscernible ways – that they're not separate entities. In other words, things that are happening in our offline

"What we're starting to see as the research matures is that it doesn't make sense to consider social media as a root cause of mental health issues"

lives can both affect and be affected by our online world.

For example, a number of studies have shown that teenagers' online and offline social networks are very similar – they use social media and online messaging services mainly to navigate their existing relationships, not to forge new ones. Moreover, an emerging line of research suggests that the types of mental, physical and social issues that exist in childrens' lives can predict the types of problems they encounter online. For example, work published in 2018 showed that children with physical disabilities or communication difficulties were more likely to engage in 'conduct' risks (say, visiting gambling websites or illegally downloading music), whereas teenagers with family or social issues were more likely to fall victim to online scams.

What we're starting to see as the research matures, is the idea that it doesn't make sense to consider social media and digital technology as a root cause of mental health issues. Instead, it's more useful to consider them as a lens through which pre-existing issues and inequalities are either dampened or intensified. They're part of a wider ecosystem of interrelated and reciprocal factors that affect our resiliency and mental health.

THE NEED TO LOOK AT THE BIGGER PICTURE

The way teenagers use social media, then, can both affect their mental health, but also be affected by it, and how problematic that resulting effect can be depends on a huge range of factors – things like what their online and offline social support networks look like, the extent to which parents and caregivers are able to provide scaffolding for their online experiences, and even age and socioeconomic status.

Recent research led by Dr Amy Orben at Cambridge University, for example, has suggested that there are critical windows of sensitivity to social media use in adolescence, and these vary by sex and age. For girls, one of the key critical periods seems to be around the ages of 11-13. Increases in self-reported social media use in this age group seem to reliably predict decreases in life satisfaction around a year later, which Orben and her team have argued may be linked to the earlier onset of puberty in females. There's a similar critical window at around age 19 for both sexes, which tends to coincide with moves away from home and disruption to pre-existing social networks.

There's no doubt that younger generations have been experiencing an upheaval in terms of their mental health over the past decade and more. If we truly care about understanding why that has happened, and doing something that will make a meaningful difference, then we need to move away from simplistic, scaremongering narratives that place the blame solely on a single source. To do so inevitably leaves us with a single, unrealistic solution: restriction.

Digital technologies aren't going to go away though, and if we restrict their access in the wrong way, we remove the potential for children and adolescents to develop much-needed skills and competencies, alongside an important source of social connection.

My daughter hasn't asked for a phone again since that initial conversation. Maybe it was just a passing thought; maybe she had actually just been talking about a toy. I'm fully aware that it's a topic of debate that will come up again with her in the future, though, as it will for many people in my position. So if we want to empower parents to have better conversations about how best to maximise the benefits and minimise the risks of online life, the public debate about screens needs to be approached differently.

In that regard, both journalists and researchers have a duty to start approaching the issue with the level of maturity, rationality and objectivity that it so desperately needs. **SF**

by PROF PETE ETCHELLS *(@PeteEtchells)*
Pete is a professor of psychology and science communication at Bath Spa University. His research specialises in the effects playing video games has on our behaviours.

SIGNS TRO

WORDS: GINNY SMITH

A group of researchers say they've found a way to screen teenagers' brains for mental health issues... before the issues manifest

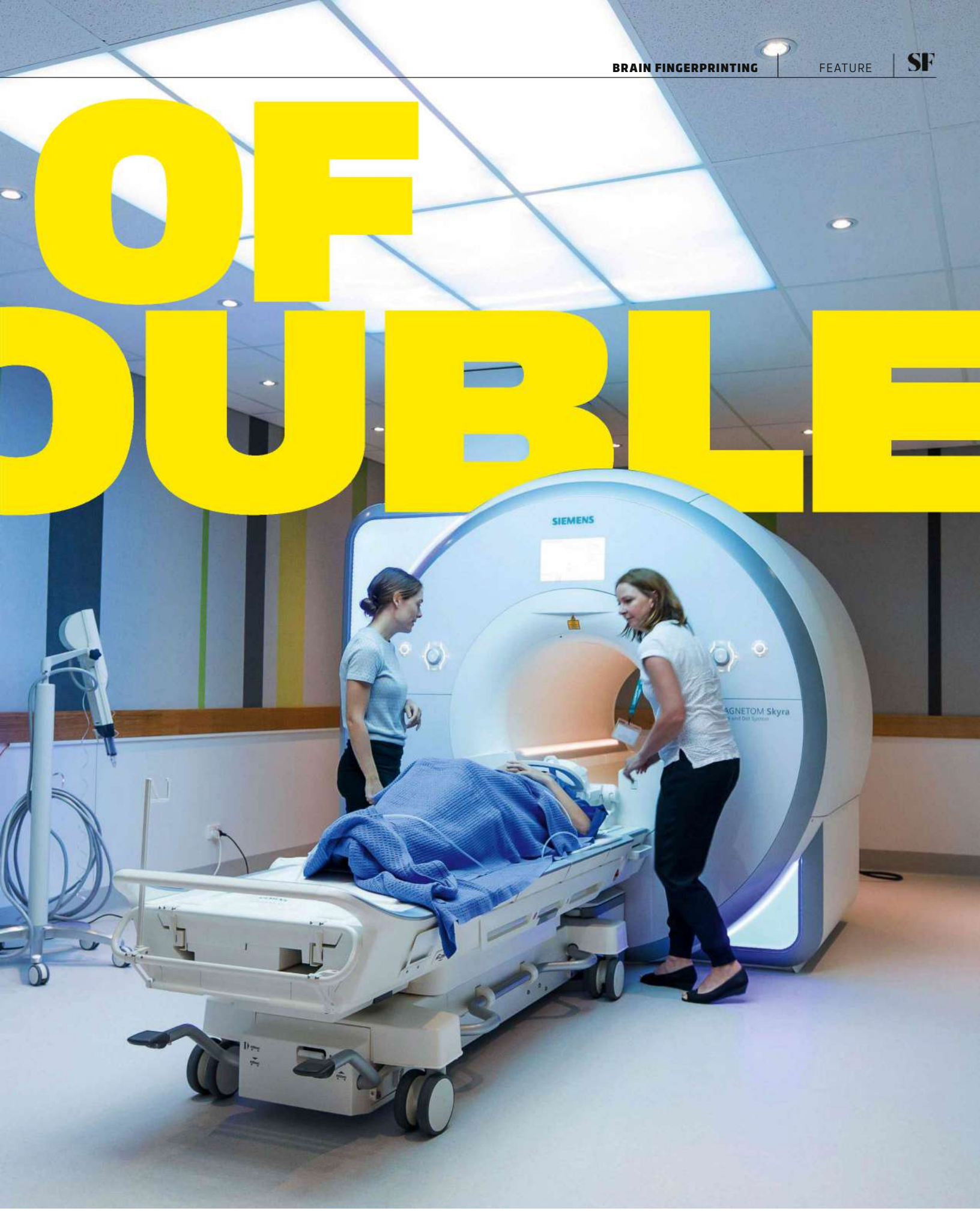
Mental health conditions are not only common, they're increasing, with one report estimating that 1 in 6 children had a probable mental health condition in 2021. The NHS spends £15.5 billion every year on treatment and still thousands of people who could benefit from help are unable to access it. But what if there was a way to detect people who were at risk of developing a mental health condition, and intervene, before they even began experiencing symptoms? That's exactly what a new paper, published in the journal *NeuroImage*, claims to have done.

The researchers used a database of brain scans of teenagers from the Sunshine Coast, on the eastern edge of Australia. The first scans were taken when the teenagers were 12 and taken again every four months for the next five years. The researchers were able to use the scans to predict which participants would go on to score highly in a survey about 'mental distress', which measured anxiety and depression symptoms. This is particularly important because 50 per cent of mental health conditions start before the age of 14, and 75 per cent by the age of 25. And intervening early can often be the difference between someone having a single episode or living with a life-long condition.

"I think the brain is one of the most complex things on Earth and there are a lot of things we still don't know about it," Associate Professor Zach Shan, head of Neuroimaging Platform at the University of the Sunshine Coast's Thompson Institute, and lead author in this new study, told me. "More and more people believe mental health problems originate →

UNIVERSITY OF THE SUNSHINE COAST

OF DOUBLE



"THE CINGULO-OPERCULAR NETWORK IS ALSO LINKED TO COGNITIVE FLEXIBILITY – THE ABILITY TO CHANGE OUR BEHAVIOUR AND THINKING"

→ during adolescence, so our team wanted to see if we could use brain imaging to monitor or pin down when it starts."

WHY TEENAGERS?

Our brains go through huge changes throughout childhood and adolescence. First, billions of new connections are made between neurons as we take in information and our amazing, flexible brains change based on our experiences. Then, the most used pathways begin to strengthen and a process known as pruning trims away unnecessary connections. This helps us become experts at the things we do a lot, while also making it harder (though not impossible) for our brains to change. At the same time, the myelin, or white matter, that wraps around our neurons, protecting them and making them more efficient, grows rapidly.

This process happens at different rates in different brain areas. Our visual system finishes pruning and reaches its full, adult-level maturity, by age 11. But other areas take much longer and the last to finish developing is the pre-frontal cortex, behind the forehead, which isn't fully mature until our mid-twenties. In adults, the pre-frontal cortex helps regulate our emotions, by keeping our reactive limbic system (the emotional part of the brain) in check. It allows us to control our temper and ignore that little voice that tells us everyone is staring at us.

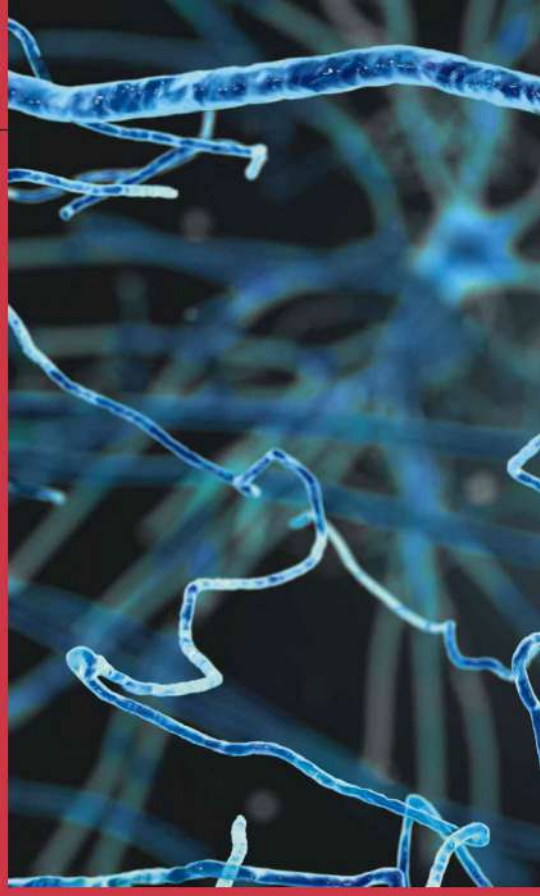
In teenagers, the limbic system is fully developed and reacting to the environment around them, but without the control of the calm, rational pre-frontal cortex. This might be one reason teenagers are so susceptible to mental health conditions, particularly depression and anxiety. In fact, researchers have found that teenagers whose myelin grows more slowly in the pre-frontal cortex are more likely to struggle with their mental health.

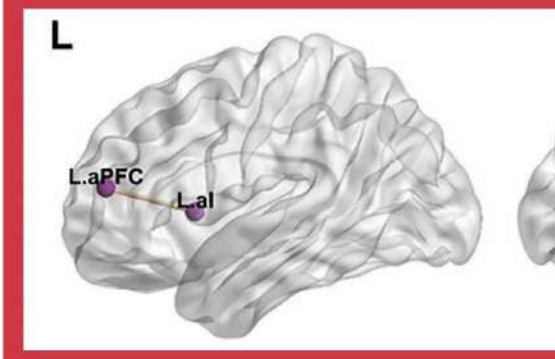
Of course, there are also lots of other factors going on during our teenage years that might contribute to this risk profile.

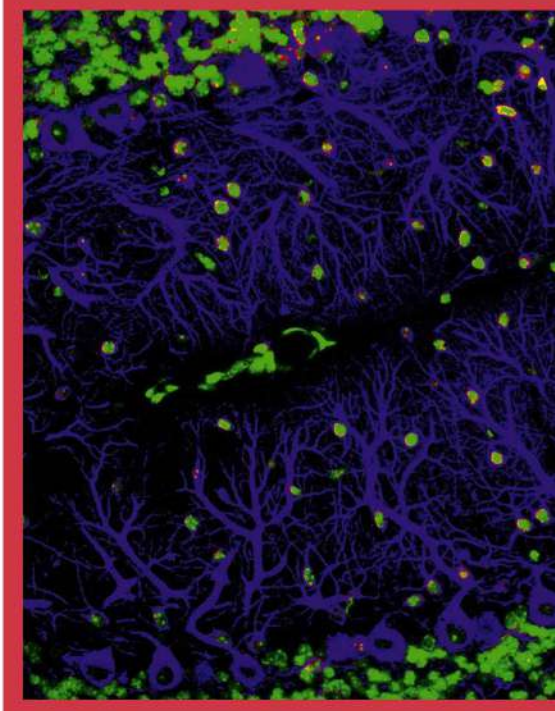
"We have a lot of societal and environmental influences that play a role. You have to become more independent, find a job, get along with your peers and your family isn't making all the decisions for you any more," says Tobias Hauser, Professor of Computational Psychiatry at the University of Tubingen and University College London. "And then also there's puberty, which is a huge change in your body, and has a big impact on your brain and mental health as well."

DEVELOPING UNIQUE BRAINS

Back on the Sunshine Coast, the researchers decided to look at the 'functional connectome' of the adolescents in the database. This is a measure of how different brain regions work together, in this case while people are resting. Previous research found that adults have unique functional connectomes – each of our brains is wired slightly differently and you can use this 'brain fingerprint' to identify people from their brain scans.







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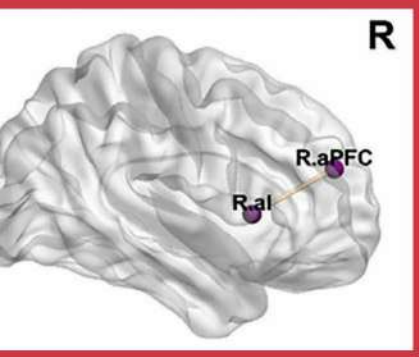

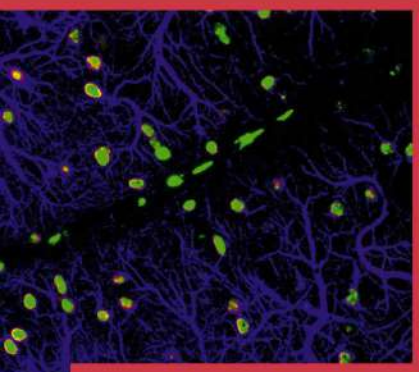

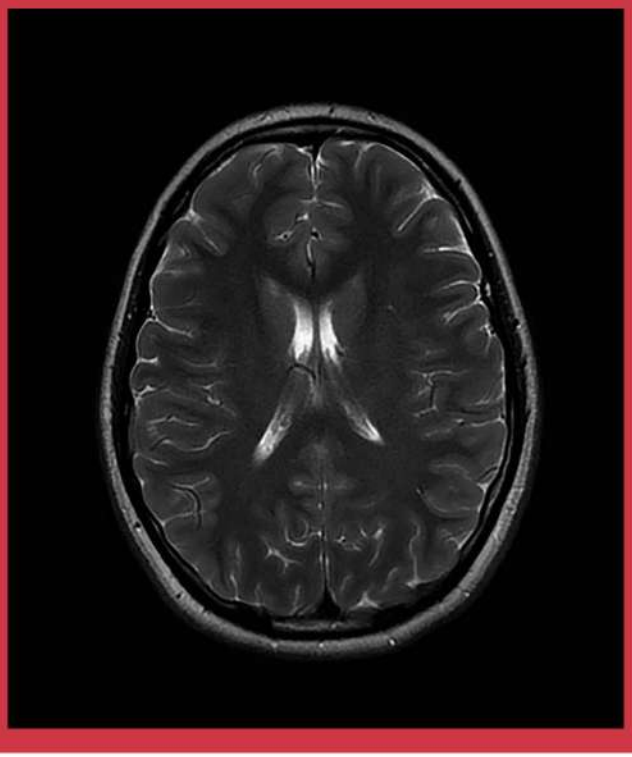

CLOCKWISE FROM TOP Billions of new connections between neurons are established during our teenage years; A teenager's brain, as seen by a magnetic resonance imaging scan; Purkinje nerve cells (blue), in the cerebellum, undergo synaptic pruning as we age; the brain's cingulo-opercular network contains the left and right anterior prefrontal cortex (aPFCs) and the anterior insulas (als)

This study found that even at 12 years old, participants' whole-brain connectomes were already unique, and the idiosyncrasies increased with age. The authors believe that this process, of our brains becoming more individual, is a vital sign of maturity.

As well as looking at the brain as a whole, the researchers also investigated networks within the brain. They found that some of these, including one known as the cingulo-opercular network (CON), were less consistently distinct and, vitally, that teens with low levels of CON uniqueness at one point were more likely to score highly on the measure of mental distress the next time they had data collected.

FLEXIBLE THINKING

The CON is a group of areas reaching from the frontal lobes to deep within the centre of the brain. Its function is still not fully understood but it seems to have a role in processing information, helping us focus and directing actions to help us achieve our goals.

Shan thinks that the fact that it's less well developed than other networks during our teens might explain some common teenage behaviours. "If their CON uniqueness is not yet developed, teens can't concentrate and focus for long periods."

This network is also linked to cognitive flexibility – the ability to change our behaviour and thinking. And this might explain why it has consistently been implicated in variety of mental health conditions, from depression and anxiety to obsessive compulsive disorder (OCD) – all conditions that contain an element of rigid or stuck thinking. People who are anxious, for example, worry excessively; people with depression may ruminate, thinking negative thoughts about their lives; and those with OCD have intrusive thoughts and compulsions to perform →

"PREVENTING, RATHER THAN TREATING, MENTAL ILLNESSES COULD SAVE A LOT OF PEOPLE A LOT OF SUFFERING"

→ repetitive actions. A problem with cognitive flexibility could underpin each of these issues.

So if CON uniqueness is a sign of healthy brain development during the teenage years, and problems with this network can lead to lower cognitive flexibility and higher risk of mental health conditions, it isn't surprising that individuals whose CON is slower to develop are at higher risk of mental ill health down the line. The researchers argue that we could use this fact to screen people and detect those at risk before their symptoms manifest. Then, just maybe, we could prevent them becoming unwell in the first place.

PREVENTATIVE MEASURES

Preventing, rather than treating, mental illnesses could save a lot of people a lot of suffering. But it does require upfront costs, particularly if we're talking about expensive fMRI scans, which could make it a hard sell to governments.

Luckily, there's emerging evidence that early detection of mental health conditions could save money in the long run. The £15.5 billion spent annually on treatment pales into insignificance compared to the amount mental illness costs the economy in other ways, for example, people being too unwell to work or needing time off to care for sick family members. A report published in 2022 found that mental health problems cost the UK economy at least £117.9 billion every year.

A full analysis would need to be done to see whether this particular intervention would reduce the burden of mental ill health enough to provide a financial benefit, but it's clear that, generally speaking, prevention is not only better but also cheaper than cure. For example, a review paper found that for every £1 invested in mental health interventions in the workplace, companies saved £5 in costs further down the line.

Hence the researchers behind the brain fingerprint study think it's an idea worth pursuing. "You can think of it like breast cancer screening," says Shan. "We should be thinking about monitoring brain development in adolescents if we want to prevent mental health problems."

There is, however, a significant hurdle in the way: brain scanning isn't the most accessible way for us to do this, which Prof Daniel Hermens, one of Shan's colleagues acknowledges:

"As there have been no major advances in the prediction of mental illnesses, a reliable and objective way to do this would be of great benefit to society.

"While many hospitals (and other facilities) have fMRI brain scanners, the cost remains high, hence government subsidies are required. Linking brain fingerprinting techniques to other technologies, such as electroencephalograms (EEGs), will help address access and affordability, as well as allow the application of 'wearables' that people could use to track changes in their brain patterns

UNIVERSITY OF THE SUNSHINE COAST

LEFT Associate Professor Zack Shan, of the University of the Sunshine Coast in Australia, is leading the study examining teenagers' brain scans

that correspond with changes in mental health and wellbeing.

One group working on an alternative is the Developmental Computational Psychiatry Lab, led by Prof Tobias Hauser. The group's app, Brain Explorer, collects data as people all over the world play games that test their cognitive abilities. The group found that these give similar results to tests administered in the lab, while allowing them access to a much larger and more diverse population. As well as the games, the app asks questions about players' mental health and the scientists behind it are starting to unpick links between game performance and mental illness. This would be a hugely exciting development, as asking people to play a game is much easier (and cheaper) than getting a brain scan.

"I don't see a future where we put every adolescent into a brain scanner. Financially and logistically, that would be a huge endeavour," says Hauser. "So I think the way to go is to have indices, or markers, which are easier to apply. And a smartphone app would be such a way. You could do it in schools and we can use the results to identify people more at risk."

Instead, Hauser sees brain scans as a second-line test, to be used in tandem with other factors, like the patient's history and symptoms. These can be used together to refine doctors understanding of that individual and predict their outcomes. He likens this to blood pressure testing. "Your GP measures your blood pressure. They aren't making a diagnosis from this, but if you have high blood pressure you go for more detailed testing... Only then, using these more refined assessments, might you end up getting a diagnosis," he says.

Whichever way we go about it, it's clear that preventing mental health issues before they set in could be a game-changer. And with our current mental health crisis among young people, we need something to change. I'm hopeful for a future where better understanding of the factors that lead to mental illness, both brain-based and environmental, will give more options and more ways of providing support to those who need it most. **SF**

by **GINNY SMITH**
(@GinnySmithSci)
Ginny is a neuroscience expert and science communicator. Her book Overloaded: How Every Aspect Of Your life Is Influenced By Your Brain Chemicals *is out now (£16.99, Bloomsbury Sigma)*

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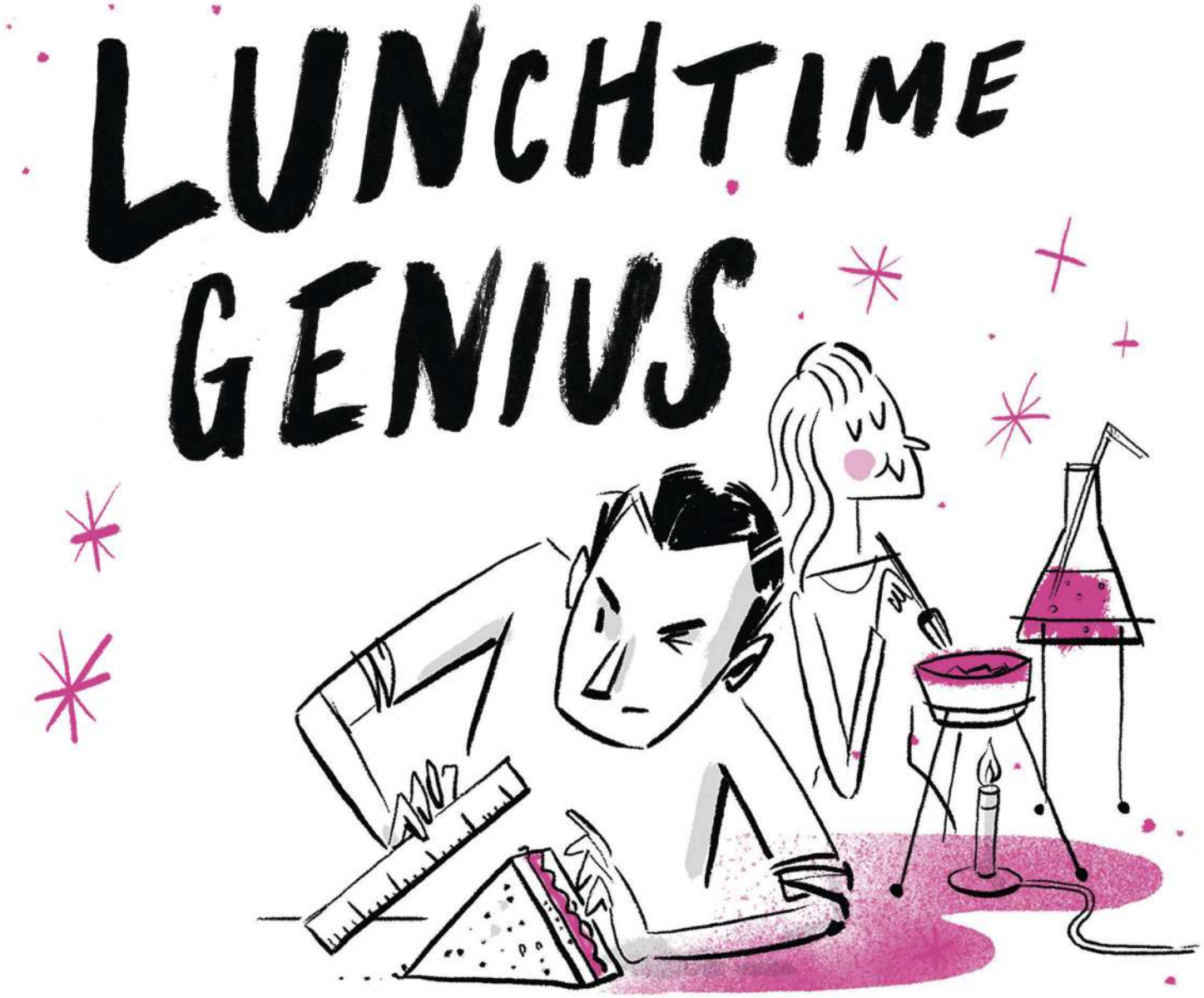

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Q&A

YOUR QUESTIONS ANSWERED

... WHY DO WE LOVE GIFS SO MUCH?
... WHAT IS THE GUNGE FROM KIDS TV SHOWS LIKE *DICK & DOM IN DA BUNGALOW* MADE FROM?
... WHY DO WE STILL HAVE DIAL TONES ON PHONES?
... WHY DOES IT GET HARDER TO STAND UP AS YOU GET OLDER?
... ARE YOGA'S CLAIMS TO DECREASE STRESS AND ANXIETY LEGIT?
... WHAT IS YERBA MATE AND SHOULD I START DRINKING IT?
... WHAT IS THE CLOSEST PLANET TO EARTH, REALLY?
... WHY DOES TIME SEEM TO SLOW DOWN IN CERTAIN SITUATIONS, LIKE WHEN YOU'RE FALLING?
... WHY DO I FEEL FINE UP TO LUNCHTIME, BUT AS SOON AS I'VE FINISHED EATING, I'M SUDDENLY RAVENOUS?

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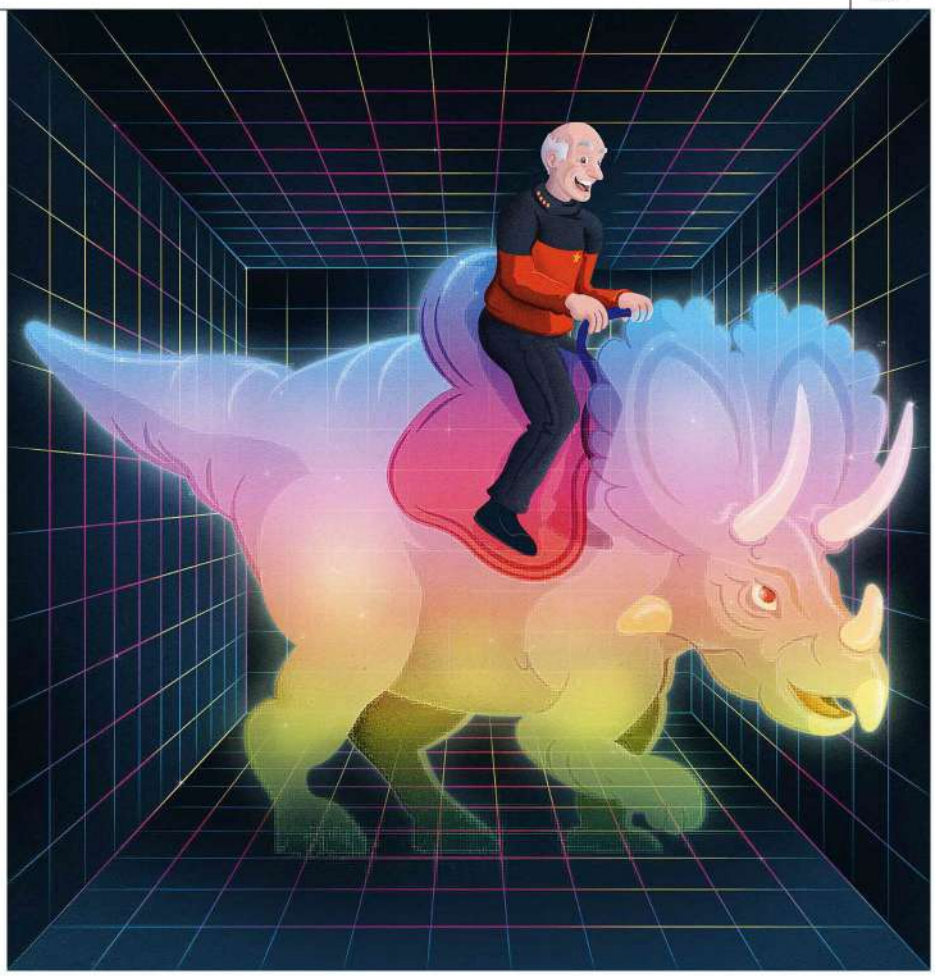


ILLUSTRATION: DANIEL BRIGHT

ANN HOFFMAN, SWINDON

WILL INTERACTIVE HOLOGRAMS EVER BECOME A REALITY, LIKE ON THE HOLODECK?

Star Trek's fictional holodeck had two major components: three dimensional (3D) images and physical interaction created by 'force fields' that made the holograms feel solid.

Today, we're getting ever closer to achieving the first of these technologies. You may remember the first attempt at 3D televisions was a flop – nobody wanted to wear silly glasses at home and the quality wasn't always great. This was known as passive 3D. Things are different now: the latest 3D screens are active 3D. A camera with some clever AI software monitors the position of your eyes and presents each one with a subtly different view, calculated to give you the perfect illusion of depth. The screens are able to present different images to your left and right eye by using a special lenticular lens layer that enables the light to be directed to the correct places, even if you move to a different position. Because it works by tracking your eyes, you don't need to wear special glasses. Some of the screens will even detect multiple people at once and show each of them the view in 3D, albeit at a reduced resolution. The first laptops and televisions with this technology are coming out now.

It's a still a little hard to make holograms that feel solid, but researchers have shown that low-frequency audio waves can be directed such that they induce force, in a method known as audio haptics. In 2021 scientists at the University of Glasgow created a system that tracks the position of your hand and then carefully pushes air with the right force in response to its movement when you interact with the virtual object. The result is that you feel as though you're touching the 3D image. Not quite a force field, but pretty good! ***PB***

LUC MEADOWS, VIA EMAIL

WHY DO WE LOVE GIFS SO MUCH?

When communicating via devices, we often want to convey complex feelings in an instant, and we don't want to faff about with fiddly little keyboards. With their dynamic images and amusing straplines, animated GIFs allow us to do just that – in a sense, we're using other people's reactions to represent our own. When a team of researchers at Yahoo! Labs analysed millions of Tumblr posts, they found that those with GIFs were the most engaging, and interviews with the users showed that the immediacy of the GIFs, their story-telling capabilities and their utility for expressing emotions were three of the main factors behind their popularity. ***CJ***

SCOTT O'BRIEN, VIA EMAIL

WHAT IS THE GUNGE FROM KIDS TV SHOWS LIKE *DICK & DOM IN DA BUNGALOW* MADE FROM?

The gunge used on kids TV shows, like *Dick & Dom...*, needs to be non-toxic, brightly coloured and sticky. There are lots of long chain polymers that can be used to make gunge, but in the UK, the most common recipe is water and powder paint, thickened with hydroxycellulose, which is plant-based and sold as Natrosol. In the US, methylcellulose is used (although, it can have laxative properties, so try not to get too much goo in your mouth). Methylcellulose is also used in wallpaper paste (but actual wallpaper paste contains fungicide, so don't use that if you're making gunge at home). ***LV***

NATURE'S WEIRDEST CREATURES...

CHINESE GIANT SALAMANDER

If you like your salamander's big, then this behemoth is for you. The smiley-faced whopper grows up to 1.8m long and weighs as much as a 10-year-old child. It sounds like a child too, making crying and moaning noises that have earned it the nickname 'wáyáyú' or 'infant fish.'

It lives in the rivers and streams of central China, where its mottled appearance helps it to blend in with the rocky riverbeds. Lacking gills, this amphibian breathes through its skin and so depends on the oxygen-rich, fast-flowing waters it calls home. There, it chows down on small animals, such as frogs, worms, fish and snails, which it draws into its mouth via a powerful suction mechanism. Prey can briefly reach speeds of up to 1.4m per second, before finding themselves inside the salamander's stomach.

A living fossil, this goliath been around since the age of the dinosaurs, but it's now critically endangered, due to habitat loss, water pollution and poaching. Wild animals are caught to supply salamander farms, which sell the animals as a luxury food item. China's government supports plans to restock the wild salamanders using farmed animals, but conservationists warn that this could transfer disease and runs the risk of hybridising populations that are genetically unique. ***HP***

ALAMY X2, BBC ILLUSTRATION: DANIEL BRIGHT

How to read a weather map...

Most of us have seen weather maps at some point in our lives – in geography lessons at school, or in weather forecasts. But what do all the lines, labels and shapes actually mean?

Infographic by James Round

1 Air pressure

Areas of high and low air pressure are labelled on weather maps with the letters H and L. High pressure generally brings calm, dry and settled weather, whereas low pressure typically means unsettled weather, with cloud, wind and rain.

2 Isobars

The continuous parallel lines with numbers on them are called isobars and connect areas with the same air pressure. The closer the isobars are together, the stronger the wind will be.

3 Weather fronts

These define the boundaries between different air masses, typically bringing cloud, precipitation and changes in temperature and humidity. They're depicted through coloured lines with shapes on one side, with the side featuring the shapes showing the direction of movement.

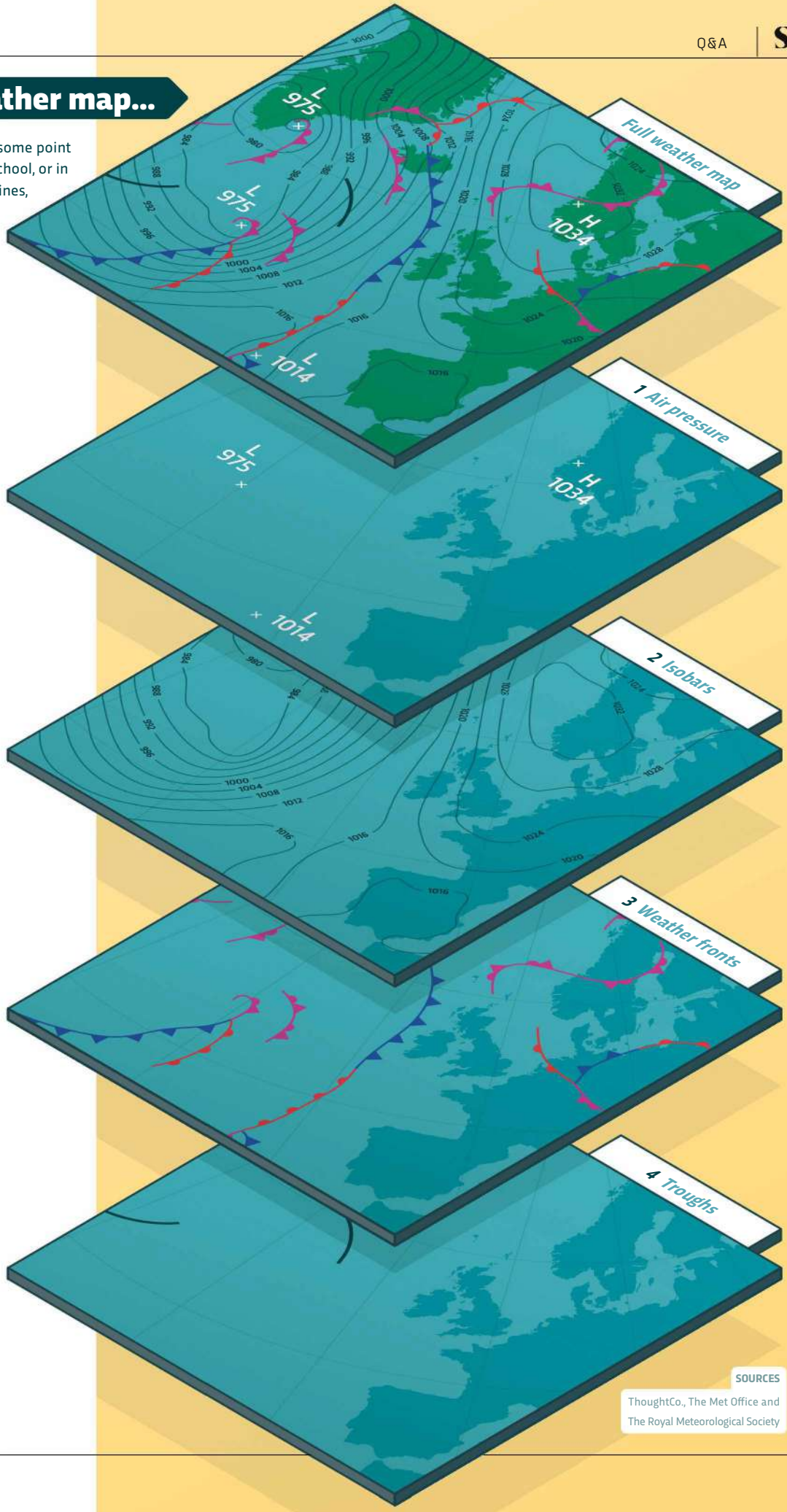
Warms fronts are shown through red lines featuring semi-circles, which resemble the rising sun. As a warm front passes through, it becomes warmer and more humid.

Cold fronts are shown through blue lines featuring arrows, which resemble icicles. As a cold front passes through, it becomes colder and drier.

Cold fronts can move faster than warm fronts, so sometimes a cold front will catch up with a warm front and force the warm air aloft. This causes an occluded front, which can have features of both warm and cold fronts. They're shown with purple lines featuring both arrows and semi-circles.

4 Troughs

A black line without any shapes on it is called a trough. This is used to show areas of turbulence and instability, and are often good indicators for rain. ***LD***



SOURCES

ThoughtCo., The Met Office and The Royal Meteorological Society

ASTRONOMY FOR BEGINNERS

GUIDING STARS

WHEN: MID/LATE MAY – JUNE

During May, the length of darkness falls dramatically and quick sky navigation helps maximise your observing time. As an example, consider this route to find an object called Messier 13. First, locate the Plough or, as it's also known, the Saucepan asterism (an asterism is an unofficial pattern), which is situated almost directly overhead as darkness falls in late May. Identify the three 'handle' stars furthest from the pan. Extend their arc away from the pan to arrive at the bright orange star, Arcturus.

Next, identify the star in the corner of the pan furthest from the handle. Extend a line from that corner star through the mid-point of the top of the pan (check the graphic above – it's easier than it sounds). Keep going for two-and-a-half times the length of the Saucepan to arrive at bright, white-blue star, Vega. A squashed-diamond pattern of stars hangs below, and is useful for confirming Vega's identity.

One-third of the way from Arcturus towards Vega you'll find the small, distinctive semi-circle of stars representing the Northern Crown, Corona Borealis. The brightest star is Gemma, the jewel in the crown.

Two-thirds of the way along the path that takes you from Arcturus to Vega, you'll find the dim-yet-distinctive Keystone asterism, which is part of Hercules the Strongman. One-third of the way between the upper-right and lower-right stars in the Keystone, is a faint object that's just visible to the naked eye under dark-sky conditions. Through binoculars the object appears like a fuzzy star, but a telescope reveals a mass of stars in a concentrated clump. This is Messier 13, the Great Globular Cluster in Hercules. Messier 13 is estimated to contain several hundred thousand stars, all gravitationally bound into a spherical region of space 145 light-years across.

One light-year is the distance light travels in a year at the speed of 299,792,458 metres per second (or 186,000 miles every second). ***PL***

SULEMAN SAID, VIA EMAIL

WHY DO WE STILL HAVE DIAL TONES ON PHONES?

The dial tone was introduced when we transitioned from human switchboard operators to automated telephone switching exchanges on the public switched telephone network (PSTN), more than a hundred years ago. Its purpose was to indicate to the phone user that the exchange was ready to accept the number, hence the name 'dial tone'.

Cellular telephone services, which don't use the PSTN, don't generate dial tones. Our mobile phones wait for us to type the entire number before connecting and transmitting it at once. Your mobile might imitate a dial tone to make you feel comfortable, but it's not performing the function it does for a landline phone.

Over the years, the PSTN has grown to connect the world, with wired connections everywhere, but it's now unsuited to handle voice, video and data. To help keep things more manageable and future-proof, the UK is switching off its PSTN in December 2025, with all services switching to the internet. This is the biggest change to our phone network for 100 years.

The dial tone is generated by the PSTN exchange, which provides power to your phone and detects when you lift the receiver. When the PSTN is switched off, power will no longer be provided and your devices will have to rely on their own local power supply, so you may need a new landline phone. This also has major implications for many kinds of device, for example: health monitors, secure phones (BRENT phones), building management systems and emergency phones in lifts, all of which need to be modified so that they continue to work.

Once we have only the internet-based system, the dial tones will be largely redundant. It's likely that we'll continue to hear them as many services use a dial tone to provide information, such as the system is operational; or a pulsed tone to indicate you have voice mail. But in reality, the dial tone will no longer be required and could be phased out altogether. ***PB***

ALEXANDRA WLECH, CUMBRIA

WHY DOES IT GET HARDER TO STAND UP AS YOU GET OLDER?

Unfortunately, we do get less flexible as we get older. Clinicians even have a test called 'Sit to Stand' (measuring the ability to stand up from a chair), widely used to examine physical function and screen older people at risk of falls and frailty.

There are lots of reasons why standing up gets harder as we age. It's thought that our tendons get tighter around joints and the cartilage between our joints deteriorates. There is also a general deterioration in ligaments and a reduction in fluid within the joint (synovial fluid) along with tightening of muscles surrounding the joint. Our muscle mass also reduces as we get older, especially muscles such as the quadriceps (around the front of your thighs), which are needed to help us stand up from a chair.

But the good news is that these changes may be slowed down. Regular physical activity is thought to slow down the deterioration in our flexibility, along with the other benefits it has for bone density, cardiovascular health and our mental health. Studies have shown that people who are physically active can achieve a greater range of motion than sedentary individuals, even in older age. NHS guidelines recommend that older adults should do activities that improve strength, balance and flexibility at least twice a week, as well at least 150 minutes of moderate-intensity activity a week (or 75 minutes of vigorous-intensity activity if you're already active).

Even if you exercise regularly, it's important to stretch properly. Yoga is great if you can manage it, but simple stretching can help with flexibility too – and can be done in front of the TV or while you're on the phone! It's worth getting someone trained to show you how to stretch properly.

Our diets are also important, particularly when it comes to nutrients like protein, which builds muscles, and calcium and vitamin D, which helps with bone density.

So yes, you might get less flexible with age and find it harder to stand up, but there are things that you can do to help! ***NM***

CROWDSCIENCE

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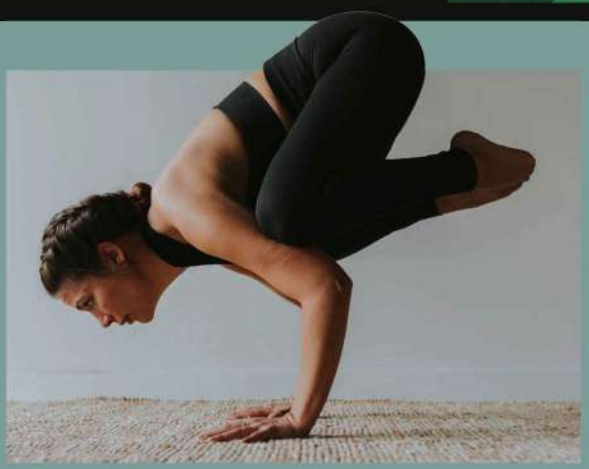
ARE YOGA'S CLAIMS TO DECREASE STRESS AND ANXIETY LEGIT?



Yoga involves postures (called 'āsanas') and regulated breathing exercises (called 'prānāyāmas'). Various studies suggest that breathing coupled with conscious movement can balance the autonomic nervous system (ANS), reduce cortisol levels and provide a sense of wellbeing.

The ANS contains the sympathetic and parasympathetic nervous systems. When you're stressed, the sympathetic nervous system releases stress hormones, which can trigger the 'fight or flight' response, causing an imbalance in the ANS. But research carried out by the Boston University School of Medicine, New York Medical College and Columbia University, found that yoga has the potential to decrease stress by balancing the ANS.

In yoga, your breathing must be controlled, and by breathing slowly and deeply you can increase the activity of the parasympathetic nervous system, which can help you feel calmer. Breathing deeply sends an activation signal to the parasympathetic nervous system, responsible for the 'rest and digest' response, which counteracts the effects of the 'fight or flight' response.

A 2019 study in Australia found that another benefit of yoga is connectedness; a shared experience and a safe space to connect with oneself and others. Other benefits, such as improvements in attention and memory, are backed by science, but to combat stress, conscious breathing is a crucial element. *VHG*

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MYTHBUSTERS

WHAT IS YERBA MATE AND SHOULD I START DRINKING IT?

When Lionel Messi, one of the world's best football players, posted a picture on Instagram of yerba mate, everyone wanted to know about the green drink and whether we should we all be sipping it. Well, it turns out the tea-like beverage does have a number of health benefits.

Yerba mate is the national drink in a number of south American countries, consumed as a morning pick-me-up in the same way Brits might have a cup of coffee or tea.

But yerba mate teabags and energy drinks, promising 'a natural energy boost' are starting to be sold on UK high streets. So, should you swap your morning cuppa for a gourd of yerba mate?

The energy boost that yerba mate offers is partly down to its caffeine content, which is about 80mg per 150ml. It's hard to compare this to a 'regular' cup of coffee because caffeine is affected by brewing time, bean choice, and other factors. But a study by *Which?* found that an average mug of tea contains 75mg, while a mug of instant coffee has around 100mg and a cappuccino from a coffee shop anywhere from 66-325mg.

Unless you have barista-made drinks every day, it's unlikely that swapping your morning cuppa for yerba mate would make much difference to your caffeine intake. But many people say that yerba mate has the wake-up properties of coffee without its afternoon energy crash.

Exactly why yerba mate drinkers avoid the caffeine crash is unknown, although it could be because the tea contains small amounts of two other stimulants, theobromine and theophylline, that stay in your body longer than caffeine. Theobromine has a longer half-life: 7-12 hours, compared to caffeine's 2.5-5 hours.

Yerba mate also contains antioxidants in the form of polyphenols, which help protect our cells from damage, while an extract form of yerba mate has been found to be slightly anti-inflammatory.

A study of 102 people who drank yerba mate three times a day saw an 8.7 per cent reduction in their levels of LDL cholesterol (the 'bad' cholesterol linked to heart disease and stroke). The extract form is of particular interest to weight loss researchers, and small studies have shown that yerba mate supplements can decrease body fat percentages and appetites. Others show that the extract increases fat burning during exercise and is thought to delay the onset of fatigue, which makes it appealing for endurance athletes. But, it's unclear whether these benefits also apply to the brewed drink.

There are, however, concerns about the hot temperature at which yerba mate is traditionally served, as they could pose an increased risk of cancers of the throat and mouth – though drinking hot coffee can increase risk of some cancers, too. ***AA***

CONRAD OWEN, YORK

WHAT IS THE CLOSEST PLANET TO EARTH, REALLY?

There has recently been some confusion over which of the planets of the Solar System is closest to Earth. The order of the planets in the Solar System, moving outwards from the Sun, hasn't changed. Earth has Venus as the next planet inwards, towards the Sun, and Mars as the next planet going outwards from the Sun. Of those two, Venus comes closer to Earth than Mars at their respective closest approaches. So, it's still correct to say that Venus comes closer to Earth than any other planet.

The confusion arises when we talk about the average distance between the planets. Now, Mercury, being closer to the Sun than Venus, orbits the Sun more quickly than our 'nearest' neighbour. Furthermore, Mercury's furthest distance from Earth (when it's on the opposite side of the Sun) is much less than the furthest distance attained by Venus.

These facts mean that, if we average the distance between Earth and these two planets, Mercury is, on average, closer to Earth. It turns out that Venus is, on average, 1.14 astronomical units (AU) from Earth, but Mercury is, on average, only 1.04 AU from Earth. An AU is a unit of length equal to the average distance between Earth and the Sun.

The recent analysis showed that, for two bodies with roughly concentric and circular orbits on the same plane, the average distance between the two bodies decreases as the radius of the inner orbit decreases. This appears to be counterintuitive. What it means is that not only is Mercury the closest planet, on average, to Earth, but it's also the closest neighbour, on average, to each of the other seven planets in the Solar System!

But the fact that the planet Venus comes closest to Earth hasn't changed. ***AG***

KACIE WONG, PETERBOROUGH

WHY DOES TIME SEEM TO SLOW DOWN IN CERTAIN SITUATIONS, LIKE WHEN YOU'RE FALLING?

Humans and other animals are good at estimating short time durations, which has led psychologists to infer that we must have some kind of internal clock. One influential theory for how this clock works is that it's like a pacemaker that releases pulses. These pulses gather in an 'accumulator' and give us a sense of how much time has passed.

But as you say, our internal clock is far from perfect, with many factors affecting how it works and distorting our subjective sense of time. A popular explanation is that this happens via the speeding up or slowing down the release of pulses from the pacemaker.

Let's take your example of falling, an experience that most people find scary. Research suggests that when we're scared, the pacemaker goes into overdrive and releases pulses more quickly. This leads to more pulses in the accumulator and an overestimation of how much time has passed.

Say you fell for five seconds – if your accumulator filled up more quickly than usual, you might judge that seven seconds had gone by. In other words, time would appear to have stretched, to be longer than it really is, which you perceive as the passage of time having slowed down. Scientists have mimicked these effects with drugs. Stimulants that increase arousal lead to overestimates of the passage of time (felt as time slowing down), while drugs, such as tranquilisers, that lower arousal, tend to lead to underestimates of how much time as passed (felt as time speeding up).

You may have noticed that in action movies, the hero will often experience time as slowed down during a dramatic event and this gives them a kind of super sense for what's going on. That would be cool if it were true, but sadly a study from 2007 suggested that that's not how it works. They tested volunteers' ability to perceive a rapidly moving image as they fell onto a safety net. The volunteers felt like time had slowed down, but it didn't help them perceive the dynamic image. ***CJ***

QUESTION OF THE MONTH

ELINOR BOESE, BERKSHIRE

WHY DO I FEEL FINE UP TO LUNCHTIME, BUT AS SOON AS I'VE FINISHED EATING, I'M SUDDENLY RAVENOUS?

It could be that you're eating too many high-sugar foods, which readily release glucose in the body. This causes a spike in insulin and a subsequent drop in blood sugar levels, which can leave you craving more of the same. Foods rich in protein and fiber take longer to digest, leaving you feeling full for longer.

The metabolic hormones leptin and ghrelin also play a role in your hunger. Leptin is a hormone made by fat cells that regulates hunger by providing a sensation of feeling full.

Meanwhile, ghrelin, known as the hunger hormone, is released primarily in the upper part of the stomach and tells your brain when you're hungry. Ghrelin levels are generally high just before eating, and low after.

But everyone is different and a number of factors affect how well the hormone system works. For instance, obesity can cause a lack of sensitivity to leptin, which can result in you feeling hungry even after eating. Prolonged periods of dieting can further weaken the satiety hormone response.

Sleep makes a big difference to hunger levels. For example, a Swedish study in 2022 showed that just one night of sleep deprivation led to lower levels of leptin and higher levels of ghrelin. The changes in leptin following sleep loss were more pronounced among women and the ghrelin increase stronger in those with obesity. Lack of sleep can lead to a strong desire to consume high-reward foods such as sugar-laden treats.

You could try eating a handful of nuts as part of your meal to stave off hunger pangs. In 2022, a study suggested that eating Brazil nuts daily for eight weeks caused lower levels of ghrelin after eating, with a potential to decrease hunger.

If you're considering adding dessert to sate your hunger, consider that MRI imaging has shown that reward centres in the brain light up at the prospect of sweet treats, with some people being more sensitive than others. You may subconsciously crave this response and override your sensation of being full from your main course. ***ED***

WINNER!

The writer of next issue's *Question Of The Month* wins a **trio of hardback popular-science books** (*The Big Bang of Numbers; Your Brain on Art;* and *Nuts & Bolts*), worth over £60.

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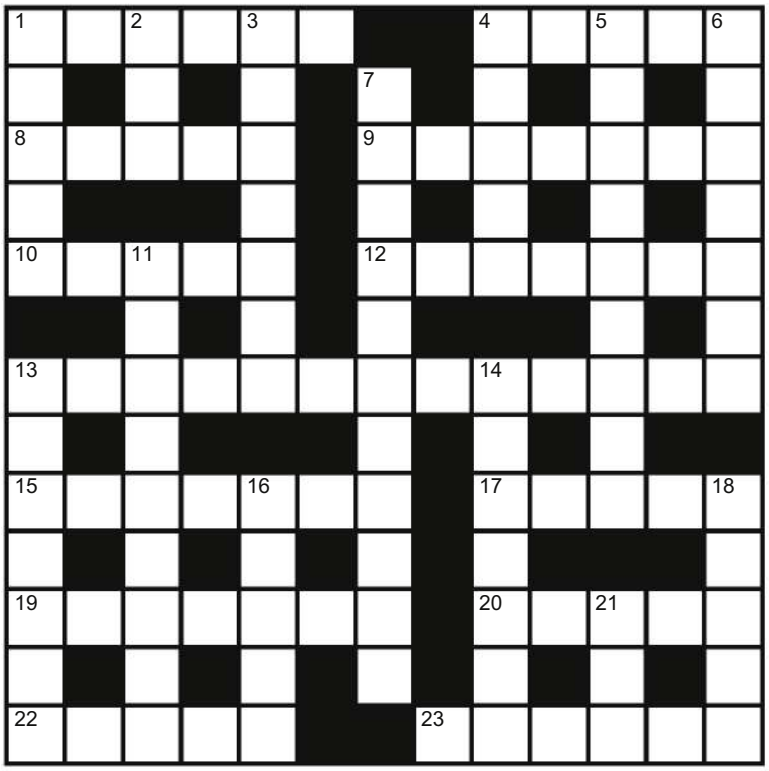
CROSSWORD

PENCILS AT THE READY!



ACROSS

1 Daisy is confused, hiding Mike's concern (6)
4 Turn up and knock middle out - article is genuine (5)
8 Teach a smidge about profound difference (5)
9 Tease two learners after party for soft toy (3,4)
10 Prima donna on new bed (5)
12 Sailor loves getting drunk, that's clear (7)
13 Deal with clause for messenger (8,5)
15 Improvises some pasta (7)
17 Live healthily, following start of diet (5)
19 Clumsy walk behind junction? Nonsense (7)
20 Youngster in charge of a particular shape (5)
22 Prominent person returning greeting in study (5)
23 Insignificant insult (6)

DOWN

1 Gambled diamonds, diamonds and more diamonds (5)
2 Wise arrangement holds a lot of water (3)
3 In the morning, I moan about gas (7)
4 Summons sheets (5)
5 Ken putting kid's first present on sill (9)
6 Friend joins listener, whatever the weather (3-4)
7 Large type of sugar distributor (11)
11 Sense Ray turning into an innovator (9)
13 Adored having space designated (7)
14 Laid car out, being thorough (7)
16 The French professor is misguided (3,2)
18 Left one cold object? That's allowed (5)
21 Eavesdrop on an insect (3)

ANSWERS

For the answers, visit **bit.ly/BBCFocusCW**
Please be aware the website address is case-sensitive.

NEXT ISSUE

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TED GRAMBEAU/INTREPID TRAVEL/UCSC/WWF

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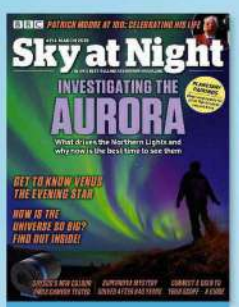

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POPCORN SCIENCE

Are mermaids real?

A marine biologist reveals whether a half-human, half-fish could survive beneath the waves

by STEPHEN KELLY

The myth of the mermaid has endured for centuries. In Ancient Syria, people worshipped Atargatis, a half-human, half-fish goddess who ruled over fertility. Then in Ancient Greece, sailors would set out to sea in fear and lust of the siren, who, if given the chance, would sing them to their deaths. And of course, there is Hans Christian Andersen's 19th-Century fairy tale *The Little Mermaid*, which has been adapted by Disney yet again, this time in live action. But how much truth is there in the myth? Does the idea of humanoid fish (or is it fishy humanoid?) have any legs? Or is it just fishful thinking?

"First of all, we know that it's possible to move around in a mermaid-style fashion," says marine biologist Dr Helen Scales. "People impersonate mermaids, and I've done the equivalent, which is using a mono-fin. Unlike bi-fins, with a fin on each foot, you put your feet together in one big tail. It's a really good way of propelling yourself around quickly." The problem, says Scales, is not necessarily with the fish part of the mermaid but with the human torso (at least, how it appears in *The Little Mermaid*), which has not evolved enough to survive for long periods of time underwater.

"My concern is respiration," says Scales. "If they need to swim to the surface to take a breath, they would need to have something more akin to a blowhole than a nose and mouth. This is why crocodiles have their nostrils higher on their heads, so it's easier for them to breathe on the surface."

If mermaids were to live a solely aquatic life, however, they would either need gills (which they don't seem to have) or, according to Scales, to have evolved some way of supplying themselves with oxygen.

"The anatomies of marine mammals are adapted to surviving in the ocean for long stretches of time," she says. "If a human diver goes underwater, their lungs halve in size every 10 metres from the pressure. Sperm whales have a special rib cage to protect their lungs when this happens. They also have a lot of myoglobin in their muscles and in their blood, which has a much higher affinity for oxygen. A mermaid would have to have something similar."

There is also the fact that the human torso, with its gangly arms and intricate fingers, might serve us well on land (they do, after all, allow us to make tools and eat pizza), but would put mermaids at a disadvantage compared to their peers.

"Arms are not particularly good for swimming, hence why whales have evolved flippers," says Scales. "When I used the mono-fin, you can really feel the drag of your arms."

The classic teardrop shape of a fish is the most hydrodynamic, adds Scales. "If mermaids had a longer evolutionary history, I would say something would have to happen to their arms," she says. "Unless, of course, there is some evolutionary reason they have arms. There could be something about their environment that makes gathering food a priority over moving quickly!"

According to Scales, the mermaid's mixture of human and marine anatomy ultimately offers the worst of both worlds, and it wouldn't make much of a difference if they were reversed, with human legs on the bottom, and a fish head on top.

"The tail is a great way to propel around," she says. "But if they wanted to breathe, a fish front-half with gills would be very handy." But even then, how would either of their exposed human torso or flailing human legs deal with the icy cold of a winter ocean? "They would need quite thick blubber," offers Scales. "Either that, or they could go down the sea otter route and use fur."

Coming soon, to a cinema near you: *The Hairy Mermaid*. **SF**

VERDICT

The mixture of human and fish features makes it impossible for a mermaid to feasibly exist. Those poor unfortunate souls.

by **STEPHEN KELLY** *(@StephenPKelly)*
Stephen is a culture and science writer, specialising in television and film.

ILLUSTRATION: JASON LYONS

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